

BATTERY HUGER FOUNDATION INVESTIGATION
REPORT OF INVESTIGATION AND ANALYSIS

FORT SUMTER NATIONAL MONUMENT
SOUTH CAROLINA

U.S. ARMY CORPS OF ENGINEERS
CHARLESTON DISTRICT

SEPTEMBER 1, 1992

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BATTERY HUGER FOUNDATION INVESTIGATION

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1. SUMMARY. Battery Huger Foundation Investigation was undertaken in accordance with Interagency Agreement No. IA 5000-1-9505, between the National Park Service (NPS) and the U.S. Army Corps of Engineers (COE). The purpose of the investigation was to determine the effects on Fort Sumter from the demolition and removal of Battery Huger. The requirements of the agreement included a preliminary review of existing information concerning design and construction of Fort Sumter and Battery Huger, subsurface soils investigations, laboratory testing, an analysis of heave due to removal of Battery Huger, construction cost estimate, and a report.

To summarize what follows in this report, no significant movement of the walls and other structures to remain at Fort Sumter would be expected from the removal of Battery Huger. The estimated heave would vary from 1.8 inches near the center front (east side) of Battery Huger to about 0.7 inch at the rear corners next to the parade ground and 0.6 inch at the east side of the fill along the right flank of Fort Sumter. These differences in movements over the distances between them are within tolerable limits and will not be detrimental to remaining structures.

Damage could be done, however, during demolition depending upon the method used to remove Battery Huger. The method selected should create as little vibration as possible. It is recommended that the mass concrete be presplit by drilling and splitting with hydraulic splitters or expanding chemicals. Small and medium-size equipment should then be used to remove rubble and fill from inside the fort. Vibration and movement of walls should be monitored during construction.

The estimated construction cost for demolition and removal of Battery Huger and the earthfill is \$4,305,000. Engineering costs are estimated to be \$136,000.

It can also be concluded that 100 percent of primary consolidation has occurred, which means that, should Battery Huger be left in place, there would be no further detrimental effects on Fort Sumter from settlement caused by Battery Huger.

2. GENERAL. Fort Sumter, originally a 3-level structure around its perimeter walls, was severely damaged by artillery bombardment during the U.S. Civil War. After the war the rubble was cleaned up and reshaped and earthfill placed inside the walls, which now extend to just above the first level. Figure C-1 shows Fort Sumter in its present state. Only the first level gunrooms are remaining on the left flank and right face of the fort, while, on the left face, only the ruins of the first level gunrooms remain. Along the left gorge are what remain of the officers' quarters. Battery Huger and additional earthfill were constructed during a period from about 1895 to 1900. The battery was constructed primarily of mass concrete and included two 12-inch guns. Between

1950 and 1955, fill on the west side and north end of Battery Huger were excavated to about the original parade ground elevation.

The walls, casemate roofs, and other structures of what remains of the original Fort Sumter are showing cracks and other signs of deterioration, due to damage from artillery shelling, settlement, weathering, and other environmental factors. NPS is considering demolishing Battery Huger and removing the remaining earthfill in order to restore the fort to some semblance of its Civil War appearance. Any large-scale construction activity such as this would affect the structure, both during and after the work.

This report presents the results of an investigation of the effects of foundation heave or rebound on the walls and other structures of the fort which would remain after demolition and removal of Battery Huger. Also presented are recommended methods to be used for demolition, recommendations for monitoring construction activities, and a construction cost estimate for the demolition and removal of Battery Huger.

3. FOUNDATION CONDITIONS. Drilling was performed by Soil Consultants, Inc., of Charleston, South Carolina; laboratory testing was performed by the COE South Atlantic Division Laboratory, Marietta, Georgia. Subsurface investigations were begun with the drilling of three soil borings in March of 1992. Using a truck-mounted drill rig, the borings were made in the parade ground along the west side of Battery Huger. The boring locations are shown on the Site Plan, Figure C-1. The drill rig was lifted over the wall at the left face of the fort by a barge-mounted crane. Three split-spoon soil borings were made, two of which were 76.5 feet deep and the third was 77 feet deep. Undisturbed samples were taken in Boring No. FS-10-92 in strata containing significant amounts of highly plastic clay. All three borings were completed to the stiff to very stiff, green, calcareous, highly plastic clays and silts, locally known as Cooper marl, which is at depths of about 70 feet near the gorge (to the southwest) and 74 feet near the salient (to the northeast). Consolidation tests were conducted on undisturbed samples to obtain compression characteristics of the more plastic soils. Laboratory tests were performed on both disturbed and undisturbed samples to obtain gradation curves and determine Atterberg limits, moisture contents, and specific gravity.

The elevation of the parade ground where the borings were made is about El. 10 NGVD (National Geodetic Vertical Datum). Based on the soil borings, soils below Battery Huger are fairly consistent with the layers dipping from 1 to 2 degrees to the northeast. To generalize foundation materials below Battery Huger, the upper 10 to 13 feet is fill consisting of fine, loose poorly-graded sands with from 4 to 10 percent fines placed over what was once an underwater shoal. The northeast and southeast ends of Battery Huger are situated over portions of the stone foundation which was placed around the perimeter of Fort Sumter below its walls. The stone foundation consists of from 5 to 6 feet of dumped granite overlaid with about 6 feet of fitted stone. The foundation soils below the fill, to a depth of about 33 feet below

the surface of the parade ground, consist generally of medium dense to dense silty sands with from 7 to 42 percent fines. At a depth of about 30 feet, thin interbedded clay lenses, varying in thickness from 1/16 inch to 1/2 inch begin to appear. From a depth of about 33 feet to 35 feet, there is a layer of loose clayey sand with numerous clay lenses of up to about 1 inch thick. Below this layer to a depth of about 56 feet, soils consist of loose to medium dense silty sands with thin interbedded clay lenses of varying thicknesses. From a depth of about 56 feet to 60 feet are interbedded layers, 1 inch or more in thickness, of soft clay of high plasticity and loose clayey sands. Soils from 60 feet to 70 feet are loose to medium dense silty sands with thin interbedded layers of highly plastic clay. At a depth of approximately 70 feet is the top of stiff to very stiff, green, calcareous clays and silts of high plasticity.

Both Boring Nos. FS-8-92 and FS-9-92 penetrated about 4 feet of granite just beneath the surface indicating the presence of the mole foundation.

The soil profile is shown on Figure C-2. Logs of borings and results of laboratory testing are included in the appendix.

4. CONSOLIDATION TESTING. Consolidation tests were conducted on undisturbed samples obtained from Boring No. FS-10-92 which was located adjacent to Battery Huger near its northwest corner. The boring was taken within the parade ground area about 8 feet from the wall of the structure. Top of ground is about El. 10.0 NGVD as measured from the top of the wall. Fill in this portion of the parade ground was once at about El. 23.9 according to the survey made in August 1901, after the completion of Battery Huger. Foundation soils below the parade ground and above marl should therefore be slightly overconsolidated in their present state.

As discussed in Section 2, above, the soils above marl can be described, in general, as silty sands and clayey sands with thin interbedded clay lenses of varying thicknesses. The clayey sand layer about 35 feet deep contained a sufficient number of such lenses to allow a sample to be retrieved using a thin-walled tube sampler. The soil stratum at a depth of about 60 feet included a layer of clay 1.5 feet thick in Boring No. FS-8-92 and about 2.5 feet thick in Boring No. FS-9-92. Thin-walled tube samples of this material were also taken for laboratory examination and testing.

The results of consolidation testing are included in the appendix.

5. ANALYSIS OF HEAVE. The loading on foundation soils would be reduced with the demolition of Battery Huger and the removal of the earthfill located on its east side. Battery Huger is constructed of mass concrete which is as much as 28 feet high and 20 feet thick at the front (east side) of the structure, resulting in a load of up to 2.1 Tsf (Tons per square foot). Because of powder magazines, shot rooms, storage rooms, guardrooms, and hallways formed within Battery Huger, loads toward the rear are about 0.9 Tsf. Reinforcement consists of a structural steel mat placed directly on the foundation below the structure, and structural steel members and corrugated steel sheeting placed above the sto-

rage rooms and passageways formed inside the building. Earthfill, which is to be removed from the east side of Battery Huger, is a maximum of 21 feet deep at the front of the battery and about 18 feet deep at the wall on the right flank of the fort.

With the removal of these loads, the foundation soils would heave due to expansion. The estimated heave for several key points on Battery Huger are given in Table 1, below. These estimates are based on the results of consolidation tests on samples of clay and clayey sand strata, and a correlation for the remaining soils which are mostly silty sands. The correlation for sand provides for some conservatism in the final estimates because it is based on the compression index rather than the swelling index as obtained from testing a poorly-graded, although clean, river sand. Another indicator of potential heave, based on the Atterberg limits and clay fractions of the soils, is the activity of the clay, which is not high, suggesting that rebound will not be significant.

Because of the variation in the loads from one part of Battery Huger to another, differential movement will result. A method for measuring this difference is to use the ratio of differential movement between two points on the structure to the distance between the points, which is called angular distortion. Table 1, below, includes estimated heave at several representative locations and the associated angular distortion based on the maximum movement of 1.80 inches of heave, which is estimated to occur at Point G, near the center front portion of Battery Huger. Locations of points are shown on Figure C-1. Data given are for the northeast end of the building near the salient, but heave would be similar for the opposite end near the gorge because the existing loads are about the same. Complete settlement data are included in the appendix.

TABLE 1 -- ESTIMATED HEAVE AND ANGULAR DISTORTION
WITH RESPECT TO POINT OF MAXIMUM HEAVE

POINT	LOCATION	ESTIMATED HEAVE (INCHES)	ANGULAR DISTORTION
G	Center front of Battery Huger	1.80	-
A	Northeast corner (near left face)	0.66	1/1368
B	North end (near salient)	1.10	1/1800
D	Southeast end of fill (near right shoulder angle)	0.58	1/1967

Angular distortion between other locations on the structure may be of concern. Since the estimated differential movement between points A and B at the end of Battery Huger is 0.44 inch and the distance between them is approximately 65 feet, the angular distortion between them would be about 1/1364. Also, the

heave at Point D' outside the fort wall 15 feet from Point D is estimated to be 0.50 inch, resulting in differential movement of 0.08 inch between points D and D' and an angular distortion of $1/2250$. Heave or settlement at Point D', as at all other points, is based upon elastic theory which shows that vertical stresses are increased throughout the soil mass by an applied load.

Differential movement can cause structures to distort. Moderate differential movements can cause tilting and cracking in structures such as the masonry walls at Fort Sumter. Increasing differential movement may result in more extensive tilting and cracking affecting structural integrity or, at least, causing an increase in the rate of deterioration from environmental effects such as weathering. Recommended limits, defined in terms of angular distortion, are established for the amount of differential movement that a structure can tolerate without cracking. For long masonry structures of low to moderate height, such as those at Fort Sumter, the allowable would be $1/500$ (0.002). Based on the estimated movements the minimum angular distortion would be about $1/1300$ at the wall along the left face, which is within the allowable tolerance of $1/500$. Therefore, no significant effects on walls, gunrooms, and other structures at Fort Sumter are expected to result from heave when Battery Huger is removed.

The calculated coefficient of compression, C_v , for clays in the foundation is $62.5 \text{ ft}^2/\text{year}$. Based on that, 100 percent of primary consolidation has been achieved. However, the void ratio of the soils will continue to decrease slightly, causing settlement, but at a very slow rate. This secondary compression is very low and any settlement will be negligible relative to settlement that has already occurred. Therefore, there would be no additional effects of a significant nature on Fort Sumter due to settlement, if Battery Huger were to remain in place.

6. DEMOLITION METHODS. The methods employed for demolition should be such that vibration is held below levels damaging to Fort Sumter structures. Existing conditions of the outer walls and casemates due to age, settlement, and environmental influences require that every effort be made to ensure no additional damage is done.

There are several methods to consider for demolishing Battery Huger, which is constructed almost entirely of mass concrete. Among these are wrecking ball, impact tools, hydraulic splitting, and expanding chemicals. The degree of control over impacts on Fort Sumter varies with each method.

Use of a wrecking ball, depending upon its weight and the drop height, within about 25 feet of the wall would create a particle velocity on the order of 0.5 ips (inches per second) and greater, which is considered to be a "disturbing" level of vibration on a loose sand or rubble foundation. One hundred feet away particle velocity would be about 0.2 ips and the vibration level would still be at least in the "strongly perceptible" range. Demolition using a wrecking ball would be difficult to control within such a low tolerance. The wrecking ball would break concrete into smaller pieces, which would increase costs for handling and removal, and would increase noise and dust.

Impact tools such as pavement breakers and large mounted rams are another method, but they tend to break concrete into small

pieces which increases handling costs. Increased noise, vibration, and dust would also be problems with this method. The use of impact tools for demolition also takes longer thereby increasing costs.

Another method of concrete demolition is the use of expanding chemicals. This method would require that holes be drilled on 2-foot centers over the entire structure. Noise and dust would be problems associated with drilling holes through concrete. This method would require a period of time between breaks while the chemical expands, but would allow for very good control of the demolition.

Splitting concrete using a hydraulic splitting cylinder is a method which would allow complete control of breakage with no damaging vibration. This equipment is small and hand-held. This method would require that up to 1.75-inch diameter holes be drilled through the concrete structure on 2-foot centers. Once holes are drilled breaks can be made in less than a minute with this equipment. Both reinforced and unreinforced concrete can be hydraulically split.

It is recommended that either expanding chemicals or hydraulic splitting be used to demolish concrete because of the reduced noise and vibration.

7. MONITORING VIBRATION AND MOVEMENT. Measurement of vibration and movement induced in structures during construction is necessary to control construction activities. Should vibration or structural movement exceed prescribed levels, then construction could be altered to correct the situation.

During demolition and removal, vibration should be monitored with velocity seismographs, one near each wall at the two ends of Battery Huger. Velocity seismographs are commonly used to monitor vibration during blasting operations. These instruments are recommended because particle velocity is measured directly, rather than inferred from displacement or acceleration from other types of seismographs. Also, velocity seismographs have a greater dynamic range and a better frequency range than displacement type seismographs.

Surface movements in walls and casemates should be observed using conventional level and position surveys. Vertical and horizontal movements should be measured to determine total movements with respect to a fixed datum located off the structures. Both translational and rotational movements would be of importance.

Lateral movement can also be measured using inclinometers securely attached to walls near the two ends of Battery Huger. Measurements should be carefully made by trained personnel at exactly the same locations in the casing during the construction period.

8. CONSTRUCTION COST ESTIMATE. Estimated quantities include demolishing 13,000 cubic yards of concrete in Battery Huger and removing 25,000 cubic yards of fill. Additional costs would be for removal and storage of such items as flagpoles. A summary of the costs is given below.

ESTIMATED COST FOR DEMOLITION

ITEM	QUANTITY	UNITS	UNIT COST	EXTENDED COST
1. Mobilization and Demobilization	Lump Sum			\$ 50,000
2. Drill Holes for Presplitting	93,000	Lin. Ft.	\$ 2.50	232,500
3. Splitting Concrete	13,000	cu. yd.	90.00	1,170,000
4. Demolition of Foundation	1,850	cu. yd.	450.00	832,500
5. Concrete Disposal	26,325	Tons	20.00	526,500
6. Sand Disposal	33,750	Tons	15.00	506,250
7. Remove and Store Flagpoles	Lump Sum			6,000
8. Supervision and Administration				120,000
Subtotal				3,443,750
Contingency (25%)				860,940
Total				\$4,304,690
Rounded				\$4,305,000

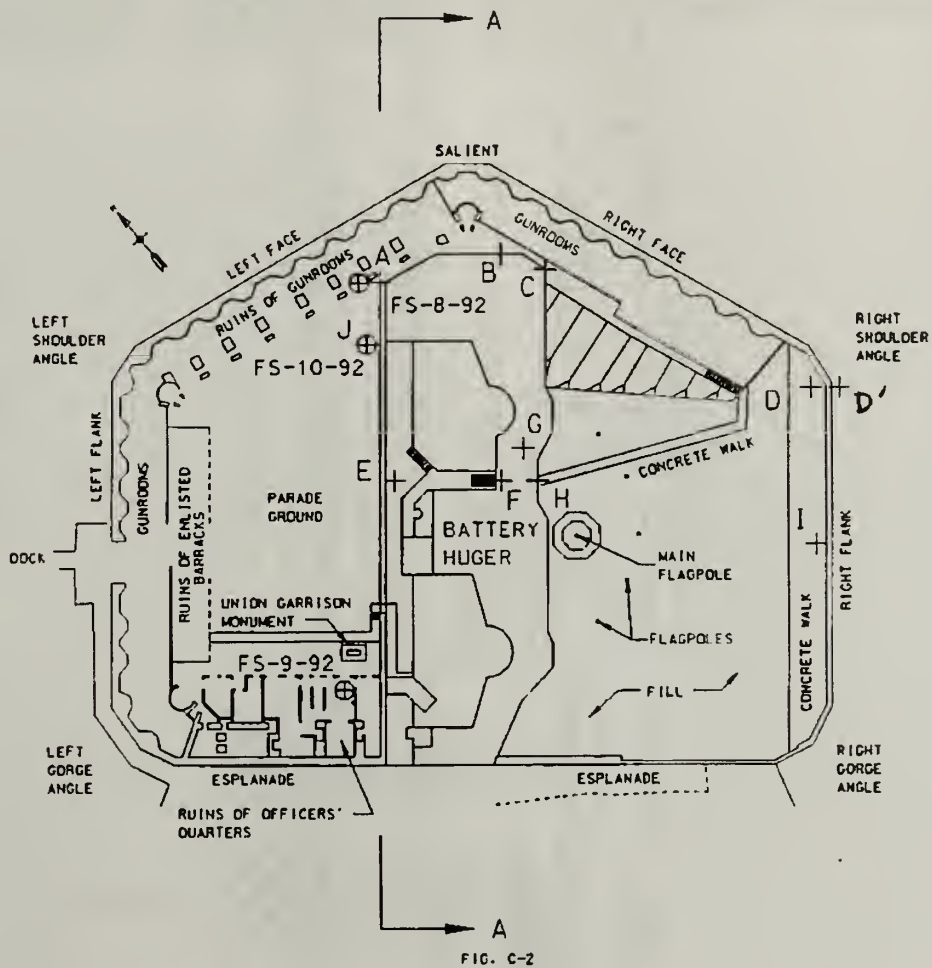
This estimate is based on offsite removal and could be reduced if portions of the materials were disposed at Fort Sumter. Some of the broken concrete may be needed for erosion protection or some of the sand may be needed for fill at locations adjacent to Fort Sumter. Permits may be necessary for such disposal. The quantities were estimated based on data from available drawings, which do not reflect recent modifications, and on observations made during site visits. A survey would be needed to refine these estimates. Engineering costs are estimated to be about \$136,000.

9. CONCLUSIONS AND RECOMMENDATIONS. No significant effects on walls, gunrooms, and other structures at Fort Sumter are expected to occur due to heave resulting from the demolition and removal of Battery Huger. However, vibration from construction activities may be significant and cause damage to the remaining structures.

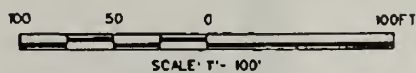
It is recommended that either expanding chemicals or hydraulic splitting be used to demolish concrete because of the reduced noise and vibration. Concrete should be broken into pieces that can be handled with equipment small enough to work inside Fort Sumter without causing excessive vibration. Large construction equipment should not be used inside the walls because of impact and vibration.

It is also recommended that vibration and movement be moni-

tored in the walls of Fort Sumter during construction using velocity seismographs, conventional surveys, and inclinometers.



FORT SUMTER



LEGEND

FS-9-92	⊕	SOIL BORING
B	+	LOCATION OF SETTLEMENT CALCULATION

bhcsdp

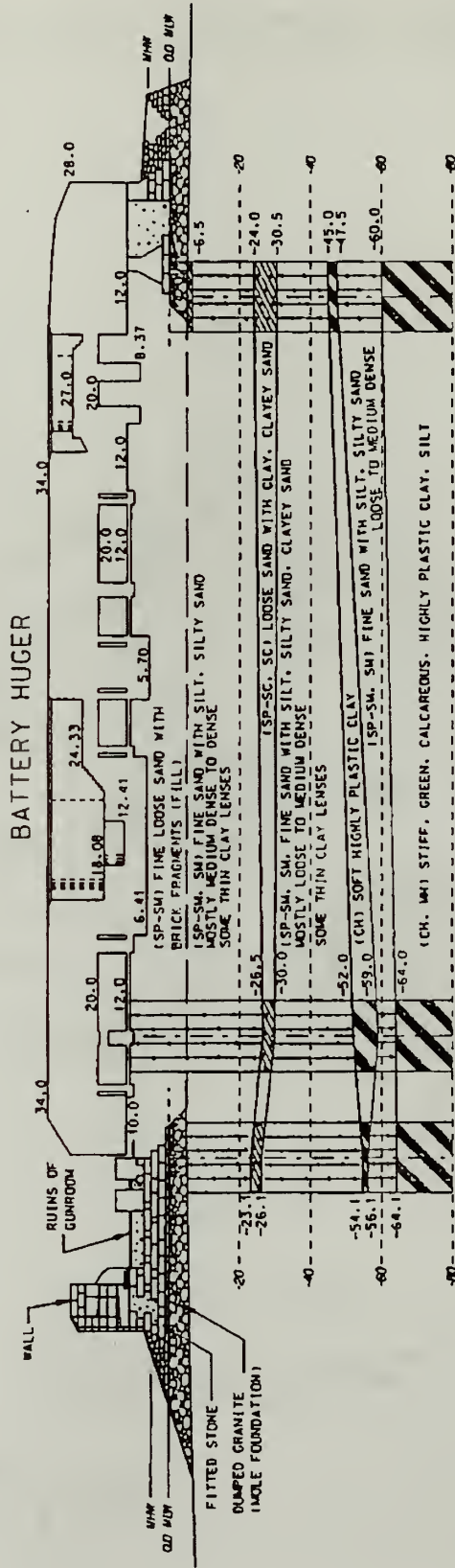
SCALE: AS SHOWN

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SITE PLAN

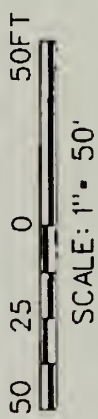
C-1

NOTE: SOILS CLASSIFIED IN ACCORDANCE WITH UNIFIED SOIL CLASSIFICATION SYTEM.



SECTION A-A

REF. FIG. C-1



bncsp

SCALE: AS SHOWN

AUGUST 1992

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SOIL PROFILE

C-2

APPENDIX

- A. HEAVE ANALYSIS
- B. BORING LOGS
- C. LABORATORY TEST RESULTS -- CONSOLIDATION TESTS
- D. LABORATORY TEST RESULTS -- GRADATION CURVES, ATTERBERG LIMITS ,
MOISTURE CONTENT, SPECIFIC GRAVITY

HEAVE ANALYSIS

U.S. ARMY ENGINEER DISTRICT, CHARLESTON
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

Page 1

Subject: Battery Huger

Computation _____ No. _____

Computed by DLH Checked by _____ Date 8-26-92

Angular Distortion Due to Foundation Heave

<u>Point</u>	<u>Estimated Heave</u>
A	0.66 inches
B	1.10
C	1.09
D	0.58
E	0.88
F	1.65
G	1.80
H	1.73
I	0.96
J	0.54

Max. heave		$\Delta_{max} = 1.80$ inches	@ Point G	Center of B.H
<u>Point</u>	<u>Distance, L, from Point G (Feet)</u>	<u>Estimated Heave, Δ (inches)</u>	<u>$\delta = \Delta_{max} - \Delta$ (inches)</u>	<u>δ/L</u>
A	130	0.66	1.14	0.00073 ($\frac{1}{1368}$)
B	105	1.10	0.70	0.00056 ($\frac{1}{1800}$)
C	105	1.09	0.71	0.00054 ($\frac{1}{1775}$)
D	200	0.58	1.22	0.00051 ($\frac{1}{1947}$)
E	80	0.88	0.92	0.00096 ($\frac{1}{1043}$)
F	35	1.65	0.15	0.00036 ($\frac{1}{2800}$)
H	35	1.73	0.07	0.00017 ($\frac{1}{6000}$)
I	170	0.96	0.84	0.00041 ($\frac{1}{2429}$)
J	110	0.54	1.26	0.00095 ($\frac{1}{1048}$)

Max. Angular Distortion, $\frac{\delta}{L} = 0.00096$ (Point E)

Angular Distortion, $\frac{\delta}{L} = 0.00073$ (Point A)

SUBLAYER

DEPTH			Ho	Po	Pp	DP	Pf	Cer	Cec	Ez	DH
TOP	BOT	AVG	FT	PSF	PSF	PSF	PSF				FT
0	10	5	10	1135	.	-715	420	0.0043		-0.0019	-0.0186
10	20	15	10	1593		-653	940	0.0043		-0.0010	-0.0099
20	33	27	13	2227		-597	1630	0.0043		-0.0006	-0.0076
33	35	34	2	2573		-573	2000	0.0062		-0.0007	-0.0013
35	46	41	11	2923		-553	2370	0.0043		-0.0004	-0.0043
46	56	51	10	3420		-530	2890	0.0043		-0.0003	-0.0031
56	60	58	4	3766		-516	3250	0.0310		-0.0020	-0.0079
60	70	65	10	4113		-503	3610	0.0043		-0.0002	-0.0024
										TOTAL	-0.0552
										=	-0.66 INCHES

SUBLAYER

DEPTH			Ho	Po	Pp	DP	Pf	Cer	Cec	Ez	DH
TOP	BOT	AVG	FT	PSF	PSF	PSF	PSF				FT
0	10	5	10	1910		-1490	420	0.0043		-0.0028	-0.0283
10	20	15	10	2280		-1340	940	0.0043		-0.0017	-0.0165
20	33	27	13	2820		-1190	1630	0.0043		-0.0010	-0.0133
33	35	34	2	3120		-1120	2000	0.0062		-0.0012	-0.0024
35	46	41	11	3430		-1060	2370	0.0043		-0.0007	-0.0076
46	56	51	10	3873		-983	2890	0.0043		-0.0005	-0.0055
56	60	58	4	4185		-935	3250	0.0310		-0.0034	-0.0136
60	70	65	10	4502		-892	3610	0.0043		-0.0004	-0.0041
										TOTAL	-0.0913
										N	-1.10 INCHES

SUBLAYER

DEPTH			Ho	Po	Pp	DP	Pf	Cer	Cec	Ez	DH
TOP	BOT	AVG	FT	PSF	PSF	PSF	PSF				FT
0	10	5	10	1800		-1380	420	0.0043		-0.0027	-0.0272
10	20	15	10	2220		-1280	940	0.0043		-0.0016	-0.0160
20	33	27	13	2810		-1180	1630	0.0043		-0.0010	-0.0132
33	35	34	2	3130		-1130	2000	0.0062		-0.0012	-0.0024
35	46	41	11	3450		-1080	2370	0.0043		-0.0007	-0.0077
46	56	51	10	3900		-1010	2890	0.0043		-0.0006	-0.0056
56	60	58	4	4220		-970	3250	0.0310		-0.0035	-0.0141
60	70	65	10	4540		-930	3610	0.0043		-0.0004	-0.0043
										TOTAL	-0.0905
										-1.09	INCHES

SETTLEMENT AT: POINT D

SUBLAYER			Ho	Po	Pp	DP	Pf	Cer	Cec	Ez	DH
DEPTH											
TOP	BOT	AVG									FT
0	10	5	10	964		-544	420	0.0043		-0.0016	-0.0155
10	20	15	10	1473		-533	940	0.0043		-0.0008	-0.0084
20	33	27	13	2149		-519	1630	0.0043		-0.0005	-0.0067
33	35	34	2	2511		-511	2000	0.0062		-0.0006	-0.0012
35	46	41	11	2873		-503	2370	0.0043		-0.0004	-0.0040
46	56	51	10	3382		-492	2890	0.0043		-0.0003	-0.0029
56	60	58	4	3734		-484	3250	0.0310		-0.0019	-0.0075
60	70	65	10	4086		-476	3610	0.0043		-0.0002	-0.0023
										TOTAL	-0.0485
										-0.58	INCHES

SETTLEMENT AT: POINT E

SUBLAYER			Ho	Po	Pp	DP	Pf	Cer	Cec	Ez	DH
TOP	BOT	AVG	FT	PSF	PSF	PSF	PSF				FT
0	10	5	10	1315		-895	420	0.0043		-0.0021	-0.0213
10	20	15	10	1826		-886	940	0.0043		-0.0012	-0.0124
20	33	27	13	2502		-872	1630	0.0043		-0.0008	-0.0104
33	35	34	2	2863		-863	2000	0.0062		-0.0010	-0.0019
35	46	41	11	3223		-853	2370	0.0043		-0.0006	-0.0063
46	56	51	10	3726		-836	2890	0.0043		-0.0005	-0.0047
56	60	58	4	4072		-822	3250	0.0310		-0.0030	-0.0121
60	70	65	10	4418		-808	3610	0.0043		-0.0004	-0.0038
										TOTAL	-0.0730
										=	-0.88 INCHES

SETTLEMENT AT: POINT F

SUBLAYER			Ho	Po	Pp	DP	Pf	Cer	Cec	Ez	DH
DEPTH											
TOP	BOT	AVG	FT	PSF	PSF	PSF	PSF				FT
0	10	5	10	3250		-2830	420	0.0043		-0.0038	-0.0382
10	20	15	10	3450		-2510	940	0.0043		-0.0024	-0.0243
20	33	27	13	3840		-2210	1630	0.0043		-0.0016	-0.0208
33	35	34	2	4070		-2070	2000	0.0062		-0.0019	-0.0038
35	46	41	11	4320		-1950	2370	0.0043		-0.0011	-0.0123
46	56	51	10	4680		-1790	2890	0.0043		-0.0009	-0.0090
56	60	58	4	4940		-1690	3250	0.0310		-0.0056	-0.0225
60	70	65	10	5210		-1600	3610	0.0043		-0.0007	-0.0069
										TOTAL	-0.1378
										=	-1.65 INCHES

SETTLEMENT AT: POINT G

SUBLAYER			Ho	Po	Pp	DP	Pf	Cer	Cec	Ez	DH
TOP	BOT	AVG	FT	PSF	PSF	PSF	PSF				FT
0	10	5	10	4160		-3740	420	0.0043		-0.0043	-0.0428
10	20	15	10	3960		-3020	940	0.0043		-0.0027	-0.0269
20	33	27	13	4120		-2490	1630	0.0043		-0.0017	-0.0225
33	35	34	2	4280		-2280	2000	0.0062		-0.0020	-0.0041
35	46	41	11	4480		-2110	2370	0.0043		-0.0012	-0.0131
46	56	51	10	4800		-1910	2890	0.0043		-0.0009	-0.0095
56	60	58	4	5050		-1800	3250	0.0310		-0.0059	-0.0237
60	70	65	10	5300		-1690	3610	0.0043		-0.0007	-0.0072
										TOTAL	-0.1497
										=	-1.80 INCHES

SETTLEMENT AT: POINT H

SUBLAYER			Ho	Po	Pp	DP	Pf	Cer	Cec	Ez	DH
TOP	BOT	AVG	FT	PSF	PSF	PSF	PSF				FT
0	10	5	10	3520		-3100	420	0.0043		-0.0040	-0.0397
10	20	15	10	3680		-2740	940	0.0043		-0.0025	-0.0255
20	33	27	13	4030		-2400	1630	0.0043		-0.0017	-0.0220
33	35	34	2	4240		-2240	2000	0.0062		-0.0020	-0.0040
35	46	41	11	4470		-2100	2370	0.0043		-0.0012	-0.0130
46	56	51	10	4520		-1630	2890	0.0043		-0.0008	-0.0084
56	60	58	4	5070		-1820	3250	0.0310		-0.0060	-0.0239
60	70	65	10	5340		-1730	3610	0.0043		-0.0007	-0.0073
										TOTAL	-0.1438
										=	-1.73 INCHES

SETTLEMENT AT: POINT I

SUBPLAYER											
DEPTH			Ho	Po	Pp	DP	Pf	Cer	Cec	Ez	DH
TOP	BOT	AVG	FT	PSF	PSF	PSF	PSF				FT
0	10	5	10	1500		-1080	420	0.0043		-0.0024	-0.0238
10	20	15	10	1980		-1040	940	0.0043		-0.0014	-0.0139
20	33	27	13	2628		-998	1630	0.0043		-0.0009	-0.0116
33	35	34	2	2972		-972	2000	0.0062		-0.0011	-0.0021
35	46	41	11	3317		-947	2370	0.0043		-0.0006	-0.0069
46	56	51	10	3800		-910	2890	0.0043		-0.0005	-0.0051
56	60	58	4	4135		-885	3250	0.0310		-0.0032	-0.0130
60	70	65	10	4470		-860	3610	0.0043		-0.0004	-0.0040
										TOTAL	-0.0804
										=	-0.96 INCHES

BATTERY HUGER

LOADS

STRESS CALCULATIONS

File Name : BHSTRESX.DAT

Output File Name : BHSTRESX.OUT

Load	X	dX	Y	dY	Z	Magnitude
1	0	20	0	65	0	3000 psf
2	20	212	0	65	0	1800 psf
3	232	43	0	65	0	3000 psf
4	0	60	65	23	0	3300 psf
5	60	90	65	23	0	4200 psf
6	150	125	65	23	0	3200 psf
7	0	275	88	80	0	2400 psf
8	0	275	168	80	0	2200 psf

Summary of Results

File Name : BHSTRESS.DAT

Output File Name : BHSTRESS.001

stress oint	X	Y	Z	bous. Sigma2	West. Sigma2
1	0	0	0	750 psf	750 psf
2	0	0	5	748 psf	715 psf
3	0	0	15	720 psf	653 psf
4	0	0	27	668 psf	597 psf
5	0	0	34	643 psf	573 psf
6	0	0	41	625 psf	553 psf
7	0	0	51	606 psf	530 psf
8	0	0	58	597 psf	516 psf
9	0	0	65	591 psf	503 psf
10	0	65	0	1580 psf	1580 psf
11	0	65	5	1570 psf	1490 psf
12	0	65	15	1510 psf	1341 psf
13	0	65	27	1410 psf	1190 psf
14	0	65	34	1360 psf	1120 psf
15	0	65	41	1310 psf	1060 psf
16	0	65	51	1240 psf	983 psf
17	0	65	58	1200 psf	935 psf
18	0	65	65	1160 psf	887 psf
19	0	85	0	1450 psf	1450 psf
20	0	85	5	1410 psf	1360 psf
21	0	85	15	1310 psf	1260 psf
22	0	85	27	1210 psf	1160 psf
23	0	85	34	1170 psf	1100 psf
24	0	85	41	1130 psf	1040 psf
25	0	85	51	1100 psf	1000 psf
26	0	85	58	1040 psf	935 psf
27	0	85	65	1000 psf	887 psf
28	0	145	0	510 psf	510 psf
29	0	145	5	550 psf	544 psf
30	0	145	15	550 psf	533 psf
31	0	145	27	550 psf	515 psf
32	0	145	34	551 psf	511 psf
33	0	145	41	551 psf	503 psf
34	0	145	51	551 psf	492 psf
35	0	145	58	551 psf	484 psf
36	0	145	65	551 psf	476 psf
37	135	0	0	900 psf	900 psf
38	135	0	5	900 psf	895 psf
39	135	0	15	903 psf	886 psf
40	135	0	27	915 psf	872 psf
41	135	0	34	926 psf	863 psf
42	135	0	41	935 psf	853 psf
43	135	0	51	950 psf	835 psf
44	135	0	58	960 psf	822 psf
45	135	0	65	975 psf	805 psf
46	135	65	0	2000 psf	2000 psf
47	135	65	5	2000 psf	1980 psf
48	135	65	15	2000 psf	1960 psf
49	135	65	27	2000 psf	1940 psf
50	135	65	34	2000 psf	1920 psf
51	135	65	41	2000 psf	1900 psf
52	135	65	51	2000 psf	1880 psf
53	135	65	58	2000 psf	1860 psf
54	135	65	65	2000 psf	1840 psf

A

B

C

D

E

F

55	103	77	0	4200 psf	4200 psf
56	103	77	5	4140 psf	3740 psf
57	103	77	15	3620 psf	3020 psf
58	103	77	27	3090 psf	1490 psf
59	105	77	34	2880 psf	2280 psf
60	105	77	41	2720 psf	2110 psf
61	105	77	51	2520 psf	1910 psf
62	105	77	58	2410 psf	1800 psf
63	105	77	65	2310 psf	1690 psf
64	138	88	0	3300 psf	3300 psf
65	138	88	5	3290 psf	3100 psf
66	138	88	15	3150 psf	2740 psf
67	138	88	27	2910 psf	2400 psf
68	138	88	34	2780 psf	2240 psf
69	138	88	41	2670 psf	2100 psf
70	138	88	51	2520 psf	1930 psf
71	138	88	58	2430 psf	1820 psf
72	138	88	65	2340 psf	1730 psf
73	138	248	0	1100 psf	1100 psf
74	138	248	5	1100 psf	1080 psf
75	138	248	15	1100 psf	1040 psf
76	138	248	27	1100 psf	998 psf
77	138	248	34	1100 psf	972 psf
78	138	248	41	1090 psf	947 psf
79	138	248	51	1080 psf	910 psf
80	138	248	58	1080 psf	881 psf
81	138	248	65	1070 psf	840 psf
82	34	-1	0	0 psf	1090 psf
83	34	-2	5	64.2 psf	228 psf
84	34	-1	15	401 psf	451 psf
85	34	-2	27	607 psf	551 psf
86	34	-2	34	10 psf	601 psf
87	34	-1	41	10 psf	611 psf
88	34	-1	51	10 psf	611 psf
89	34	-1	58	708 psf	601 psf
90	34	-2	65	708 psf	551 psf

G

H

I

J

 LOADS

a File Name : bhstresd.dat

Output File Name : bhstresd.out

Load	X	dX	Y	dY	Z	Magnitude
----	----	----	----	----	----	-----
1	0	20	0	65	0	3000 psf
2	20	212	0	65	0	1800 psf
3	232	43	0	65	0	3000 psf
4	0	60	65	23	0	3300 psf
5	60	90	65	23	0	4200 psf
6	150	125	65	23	0	3200 psf
7	0	275	88	80	0	2400 psf
8	0	275	168	80	0	2200 psf

 Summary of Results

a File Name : bhstresd.dat

Output File Name : bhstresd.out

Stress Point	X	Y	Z	Bous. SigmaZ	West. SigmaZ
----	----	----	----	-----	-----
1	138	263	0	0 psf	0 psf
	138	263	5	15.2 psf	144 psf
	138	263	15	199 psf	377 psf
4	138	263	27	445 psf	537 psf
5	138	263	34	546 psf	587 psf
6	138	263	41	620 psf	619 psf
7	138	263	51	695 psf	643 psf
8	138	263	58	732 psf	649 psf
9	138	263	65	758 psf	650 psf

POINT D'

U.S. ARMY ENGINEER DISTRICT, CHARLESTON
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

Page 10

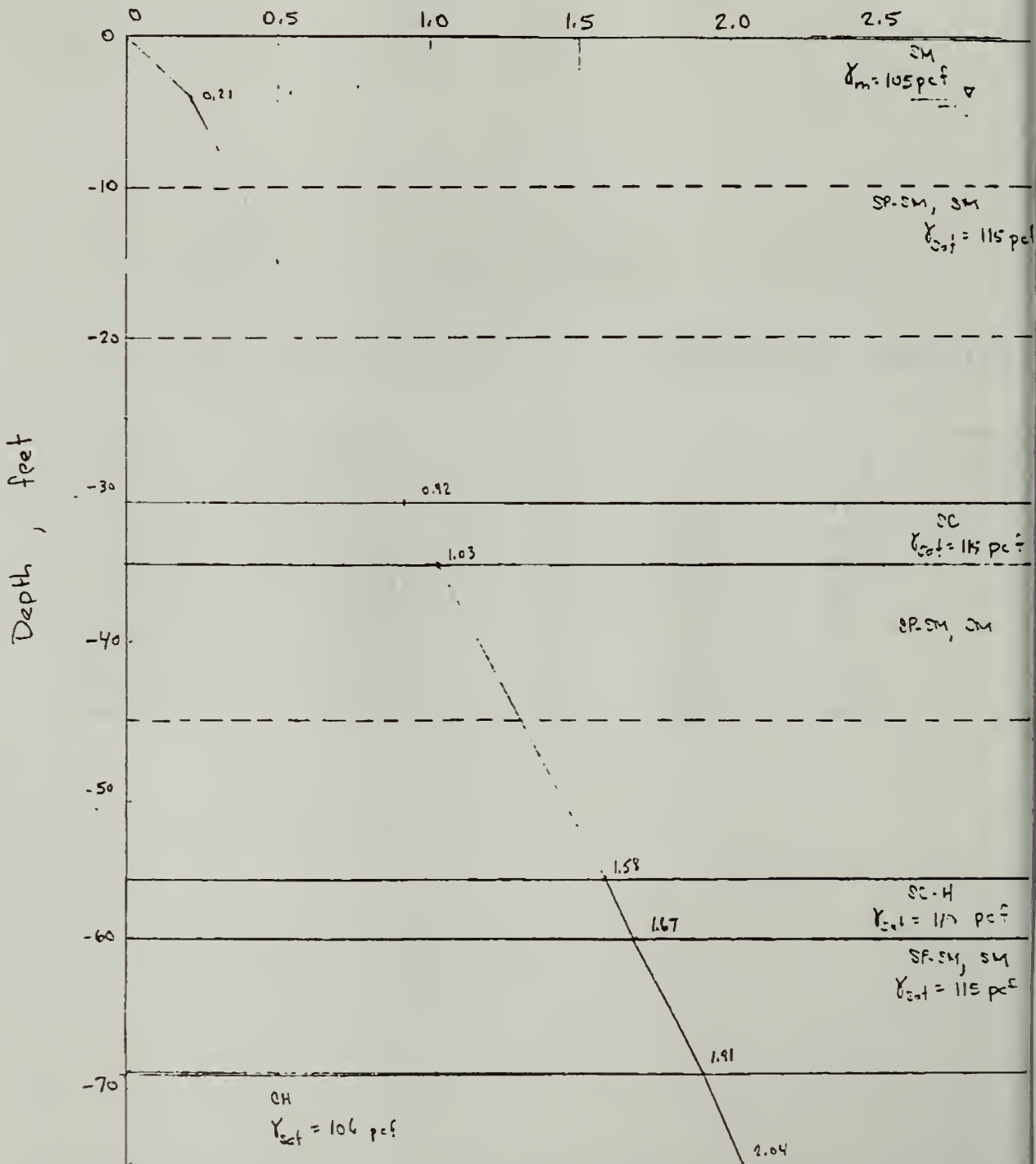
Subject: _____

Computation _____ No. _____

Computed by _____ Checked by _____ Date _____

Effective Pressure (Without Battery Huger Loads)

Effective Pressure, Tons/Sq. Ft.



U.S. ARMY ENGINEER DISTRICT, CHARLESTON
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

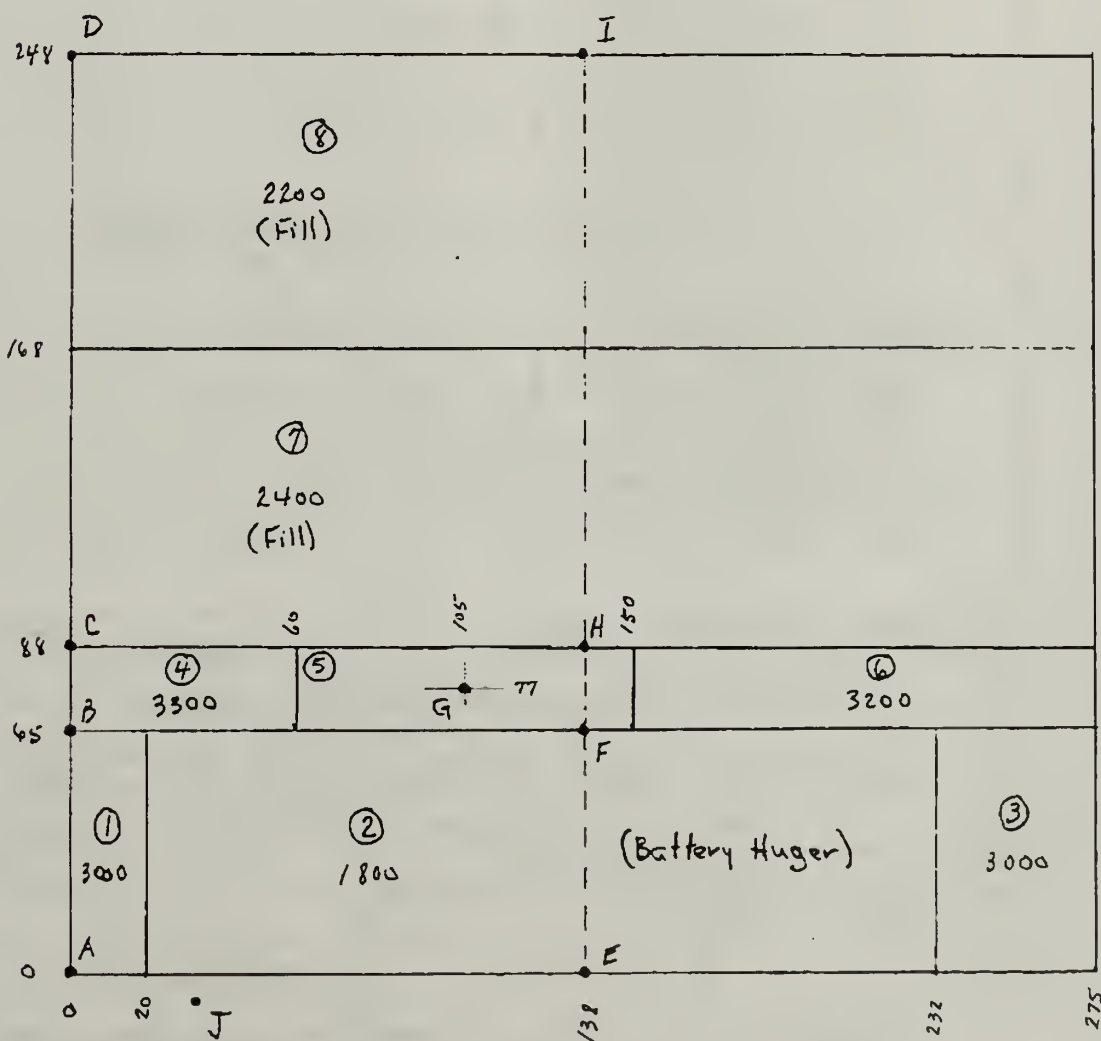
Page 11

Subject: BATTERY HUGER

Computation _____ No. _____

Computed by _____ Checked by _____ Date _____

Loading arrangement (in lb/ft²)



U.S. ARMY ENGINEER DISTRICT, CHARLESTON

CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

Page 12

Subject: Fort Sumter - Battery Huger

Computation Consolidation - Heave

No. _____

Computed by DLH

Checked by _____

Date 8-7-92

Boring FS-10-92 Sample # 6A (36.5' - 38.5')

SC $w = 38.3\%$ $LL = 29$ $PI = 7$ Activity = $\frac{7}{7.5} = 0.93$

Compression Index, $C_c = \frac{0.9933 - 0.8308}{1} = 0.1625$

Correlation: $C_c = 0.009(LL - 10)$

$C_c = 0.009(29 - 10) = 0.17$ o.k.

Virgin compression ratio, $C_{ec} = \frac{C_c}{1 + e_0}$

$C_{ec} = \frac{0.1625}{1 + 1.031} = 0.0800$

Recompression Index, $C_r = \frac{0.8608 - 0.8483}{1} = 0.0125$

Recompression ratio, $C_{er} = \frac{C_r}{1 + e_0} = \frac{0.0125}{1 + 1.031} = 0.00615$

$\gamma_{sat} = \frac{(1 + w)\gamma_w}{w + \frac{1}{G_s}} = \frac{(1 + 0.383) 62.4}{0.383 + \frac{1}{2.69}} = 114.3 \text{ lb/ft}^3$

Effective Overburden Pressure

$P_o = 4(105) + 33.5(115 - 62.4) = 2180 \text{ lb/ft}^2$

$P_p \approx 3200 \text{ lb/ft}^2$ (from Consolidation Test)

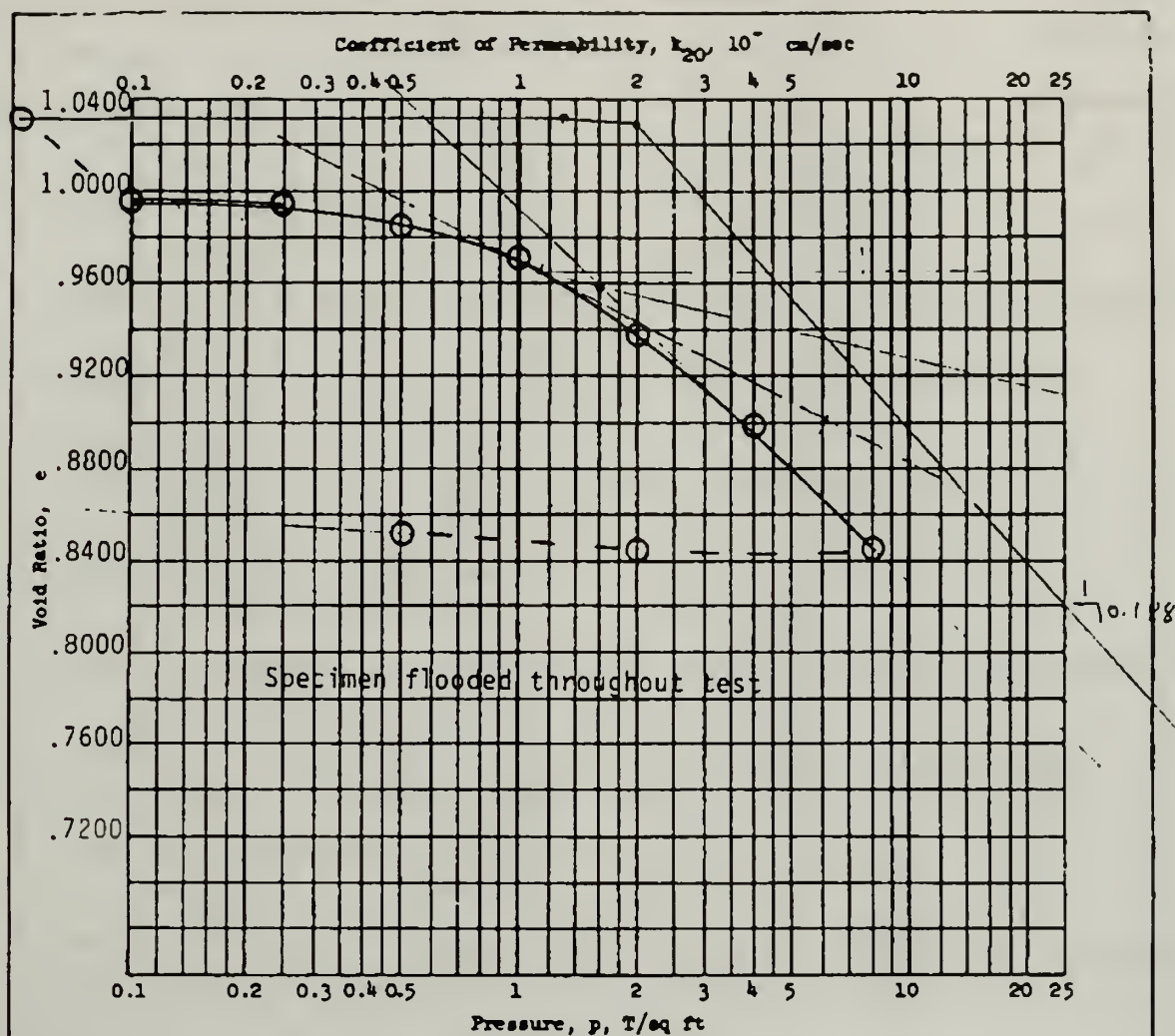
Coefficient of Consolidation

$C_v = \frac{0.197 D^2}{t_{50}}$

$t_{50} = 11.5 \text{ min}$ (from Consolidation test time curve)

$C_v = \frac{0.197 (1 \text{ in})^2}{11.5 \text{ min}} \cdot \frac{1 \text{ ft}^2}{144 \text{ in}^2} \cdot \frac{1440 \text{ min}}{1 \text{ day}} \cdot \frac{365 \text{ days}}{1 \text{ year}}$

$C_v = 62.5 \text{ ft}^2/\text{year}$



Type of Specimen		Before Test		After Test	
undisturbed					
Diam 2.49 in.	Ht 1.00 in.	Water Content, w_o	38.3 %	w_f	31.7 %
Overburden Pressure, p_o	1.3 T/sq ft	Void Ratio, e_o	1.031	e_f	.851
Preconsol. Pressure, p_c	2.0 T/sq ft	Saturation, S_o	100.0 %	S_f	100.0 %
Compression Index, C_c	0.188 Corrected	Dry Density, γ_d	82.7 lb/ft ³		
Classification SC $C_r = .0125$		k_{20} at $e_o =$ $\times 10^{-7}$ cm/sec			
LL 29	a_s 2.69	Project Ft. Sumter, National Monument			
PL 22	D_{10} .0057mm	Lab No. 96/635			
Remarks See gradation curve		Area Battery Huger Investigation			
on ENG Form 2087.		Boring No. FS-10-92	Sample No. 6A		
		Depth 36.5-38.5'	Date 14 May 92		
		CONSOLIDATION TEST REPORT			

$$C_{ec} = 0.2724$$

$$C_{cr} = 0.00615$$

U.S. ARMY ENGINEER DISTRICT, CHARLESTON
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

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Subject: _____

Computation _____

No. _____

Computed by _____

Checked by _____

Date

8-7-92

Boring FS-10-92 Sample 11B (64.0' - 66.0')

SC-H

$w = 45.8\%$

LL = 55

PI = 33

Compression Index

$$C_c = \frac{1.254 - 0.839}{1} = 0.4150$$

Correction, $C_c = 0.009(LL - 10)$

$$C_c = 0.009(55 - 10) = 0.41$$

Virgin compression ratio, $C_{ec} = \frac{C_c}{1 + e_0}$

$$C_{ec} = \frac{0.415}{1 + 1.255} = 0.184$$

Recompression Index

$$C_r = \frac{0.9110 - 0.8410}{1} = 0.070$$

Recompression Ratio, $C_{er} = \frac{C_r}{1 + e_0}$

$$C_{er} = \frac{0.070}{1 + 1.255} = 0.0310$$

Saturated Unit Weight

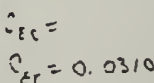
$$\gamma_{sat} = 109.8 \text{ lb/ft}^3$$

Effective Overburden Pressure

$$P_0 = 4(105) + 61(115 - 62.4) = 3630 \text{ lb/ft}^2$$

Activity

$$A = \frac{PI}{\% < 2\mu} = \frac{33}{15.5} = 2.1$$



EMG FORM 2990 PREVIOUS EDITIONS ARE OBSOLETE.
1 MAY 63

U.S. ARMY ENGINEER DISTRICT, CHARLESTON
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

Page 16

Subject: _____

Computation _____ No. _____

Computed by _____ Checked by _____ Date _____

Boring FS-10-92

Sample No. 13 (75.0' - 77.0')

Classification: CH

$$w = 52.5\%$$

$$LL = 88$$

$$PI = 51$$

$$C_c = \frac{1.4317 - 1.1288}{1} = 0.3029$$

$$C_r = \frac{1.2717 - 1.2448}{1} = 0.0269$$

$$\gamma_{sat} = 106.4 \text{ lb/ft}^3$$

$$P_0 = 4(105) + 61(115 - 62.4) + 11(110 - 62.4) \\ = 4150 \text{ lb/ft}^2 = 2.08 \text{ T/ft}^2$$

$$P_p = 2.1 \text{ T/ft}^2 \quad \text{from Consolidation Test}$$

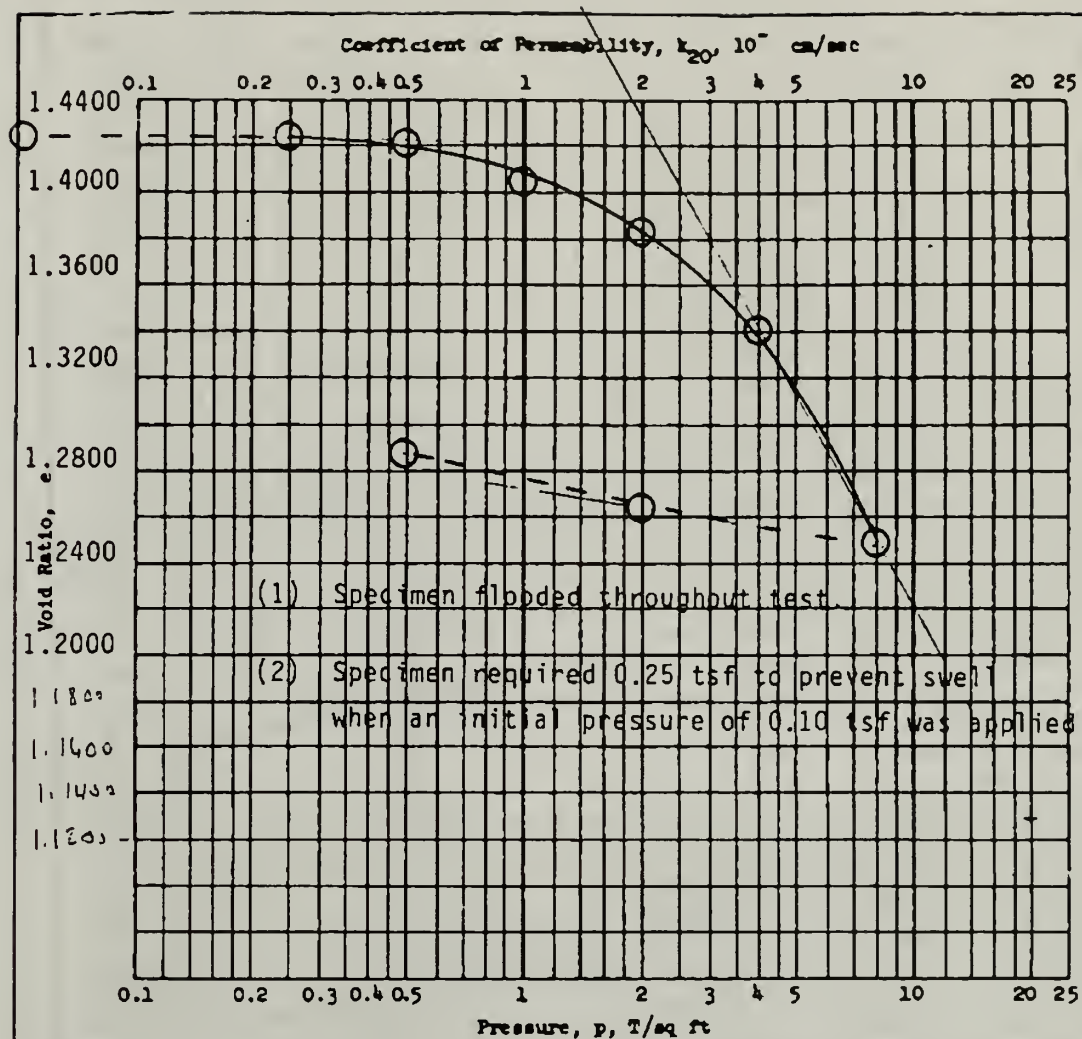
From Consolidation Test-Time curve $t_{c0} = 0.24 \text{ min}$

$$C_v = \frac{0.197 (1.00)^2}{0.24} \times 3450 = 3000 \text{ ft}^2/\text{yr.}$$

Check C_c by correlation:

$$C_c = 0.009(LL - 10) \\ = 0.009(88 - 10) = 0.70$$

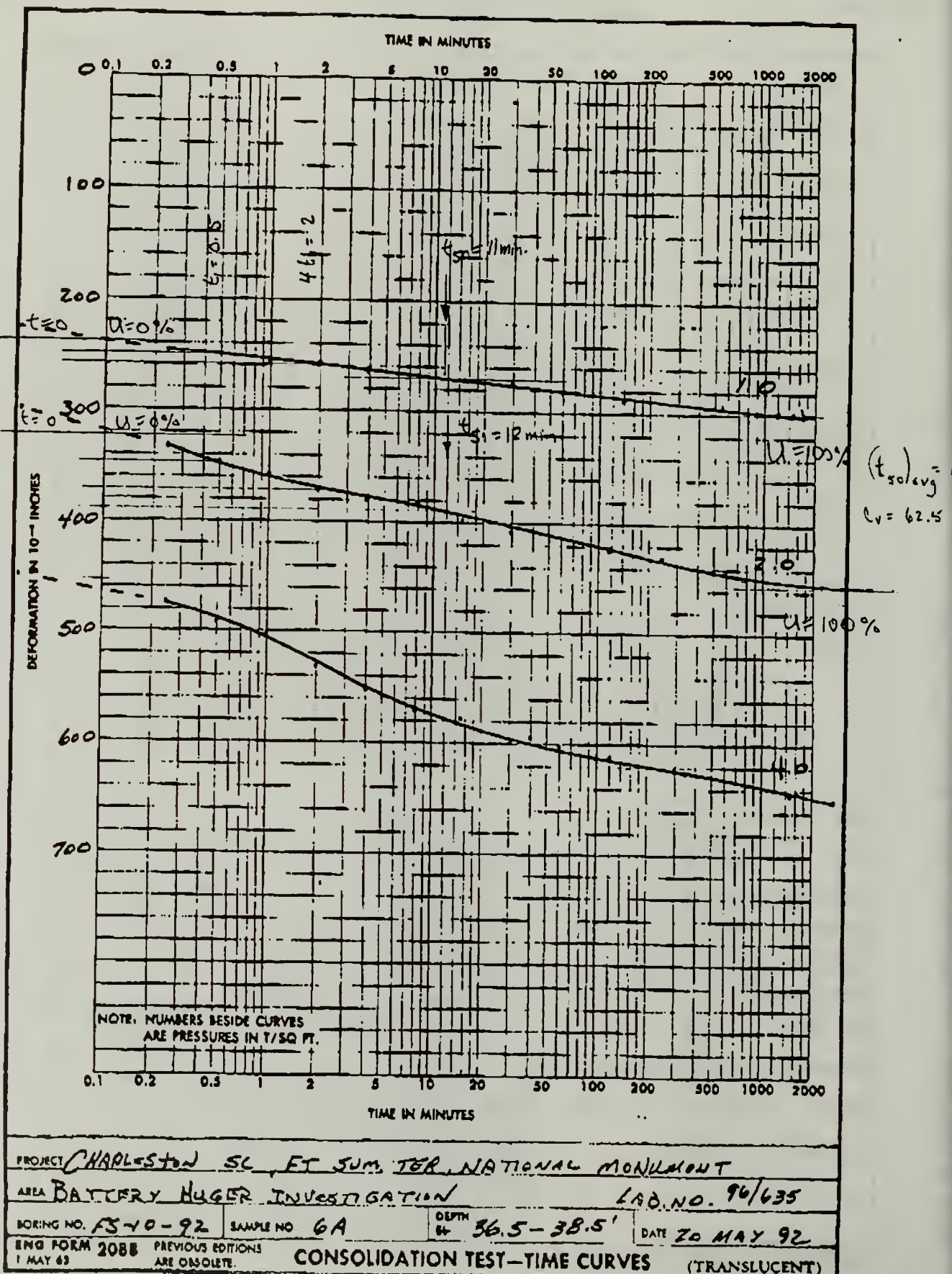
$$\text{Activity, } A = \frac{PI}{\% < \#200} = \frac{51}{25} = 2.0$$



Type of Specimen		Undisturbed		Before Test		After Test	
Diam 2.50 in.	Ht 1.00 in.	Water Content, w_o	52.5 %	w_f	47.6 %		
Overburden Pressure, p_o 2.08 T/sq ft		Void Ratio, e_o	1.422	e_f	1.2895		
Preconsol. Pressure, p_c 2.1 T/sq ft		Saturation, S_o	100.0 %	S_f	100.0 %		
Compression Index, $C_c = 0.3029$		Dry Density, γ_d	69.9 lb/ft ³				
Classification CH $C_r = 0.0392$		k_{20} at $e_o =$ $\times 10^{-7}$ cm/sec					
LL 88	q_s 2.71	Project Ft. Sumpter National Monument					
PL 37	D_{10} -	Lab. No. 96/639					
Remarks See gradation curve		Area Battery Huger Investigation					
on ENG Form 2087.		Boring No. FS-10-92		Sample No. 13			
		Depth 75.0 77.0'		Date 14 May 92			
		CONSOLIDATION TEST REPORT					

 $\gamma_{sat} = 104.4 \text{ lb/ft}^3$

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION, LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, Marietta, GA. 30066
WORK UNDER NO. 60630
Req. No. SACRM-92-84



Compression Index Correlations for Sands

19

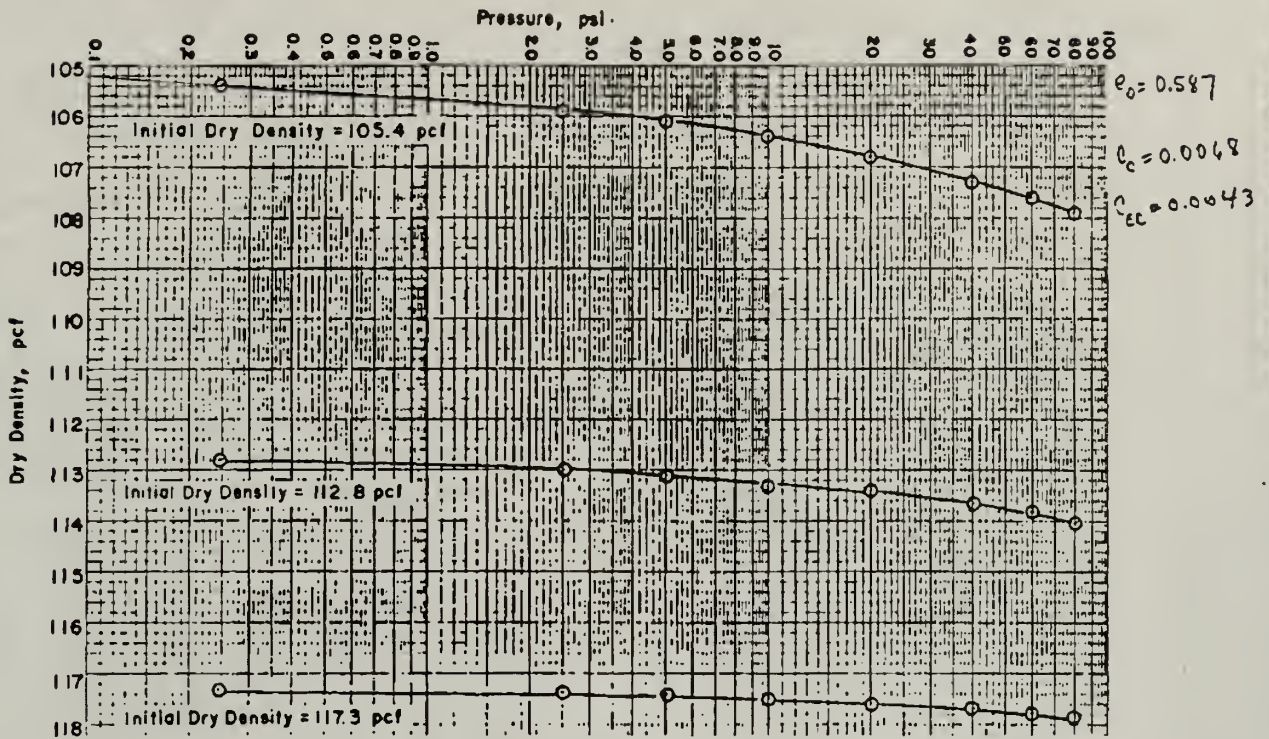


Figure 12. Consolidation test results for Platte River sand

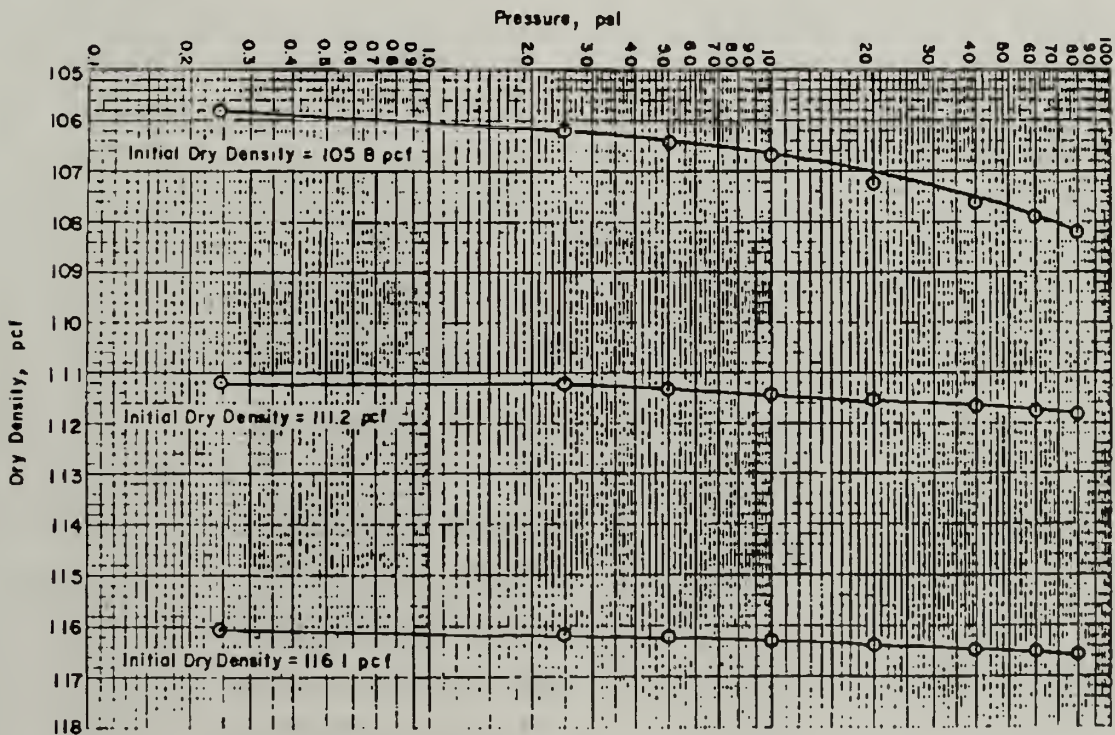


Figure 13. Consolidation test results for Standard Concrete sand

$$\gamma_d = \frac{G_s \gamma_w}{1+e} \Rightarrow e = \frac{G_s \gamma_w}{\gamma_d} - 1$$

BORING LOGS

CONTRACT NO. DACW60-92-M-0135

Hole No. FS-8-92

DRILLING LOG		DIVISION SOUTH ATLANTIC	INSTALLATION FT. SUMTER NATIONAL MONUMENT	SHEET 1 of 3 SHEETS
1 PROJECT BATTERY HUGER FOUNDATION INVESTIGATION			10 SIZE AND TYPE OF BIT	
2 LOCATION (Coordinates or Station) FORT SUMTER NATIONAL MONUMENT			11 DATUM FOR ELEVATION SHOWN (TBM or MVD) NONE	
3 DRILLING AGENCY SOIL CONSULTANTS, INC.			12 MANUFACTURER'S DESIGNATION OF DRILL	
4 HOLE NO. (As shown on drawing title and file number) FS-8-92			13 TOTAL NUMBER OF OVERBURDEN SAMPLES TAKEN DISTURBED 33 UNDISTURBED	
5 NAME OF DRILLER FRANK EATON			14 TOTAL NUMBER OF CORE BOXES NONE	
6 DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG FROM VERTICAL			15 ELEVATION GROUND WATER 4' - 0"	
7 THICKNESS OF OVERBURDEN			16 DATE HOLE STARTED 3/23/92 COMPLETED 3/26/92	
8 DEPTH DRILLED INTO ROCK			17 ELEVATION TOP OF HOLE 0' - 0" ASSUMED	
9 TOTAL DEPTH OF HOLE 76' - 6"			18 TOTAL CORE RECOVERY FOR BORING X	
			19 SIGNATURE OF INSPECTOR	

a ELEVATION	b DEPTH 0	c LEGEND	d CLASSIFICATION OF MATERIALS (Description)	e % CORE RECOVERY	f BOX OR SAMPLE NO.	g REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
			BROWN FINE SAND WITH BRICK FRAGMENTS AND SHELL CONTENT. (SM WITH SHELL)		1	AUGER BORING 0'0" TO 5'0"
	5		VERY LOOSE BROWN FINE SAND WITH HIGH SHELL CONTENT. (SM WITH SHELL)		2	1-2-1
					3	1-1-2
	10		GRANITE			
			MEDIUM GRAY FINE SAND WITH HIGH SHELL CONTENT. (SM WITH SHELL)		4	12-12-14
	15				5	9-10-12
					6	15-10-12
			MEDIUM GRAY FINE SAND WITH SLIGHT SHELL CONTENT. (SM)		7	4-12-15
	20		MEDIUM GRAY FINE SAND WITH VERY SLIGHT SHELL CONTENT (SM)		8	11-14-16
			DENSE GRAY FINE SAND WITH SLIGHT SHELL CONTENT. (SM)		9	4-14-17
					10	11-17-17
			MEDIUM GRAY FINE SAND WITH SLIGHT SHELL CONTENT (SM)		11	8-14-16
	25		MEDIUM GRAY FINE SAND WITH HIGH SHELL CONTENT. (SM)		12	9-14-13
			LOOSE GRAY FINE SAND WITH HIGH SHELL CONTENT (SM)		13	2-3-6
			MEDIUM GRAY FINE SAND (SM)		14	11-9-11
	30		MEDIUM GRAY FINE SAND WITH SLIGHT ORGANIC CLAY LENS. (SM)		15	6-7-8
			Continued on Sheet 2			BLOWS PER FOOT Number required to drive 1-3/8" ID splitspoon 12" with 140 lb hammer falling 30"

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE

0' - 0" ASSUMED

Hole No. FS-8-92

PROJECT

BATTERY HUGER
FOUNDATION INVESTIGATION

INSTALLATION

FT. SUMTER NATIONAL MONUMENT

SHEET

2

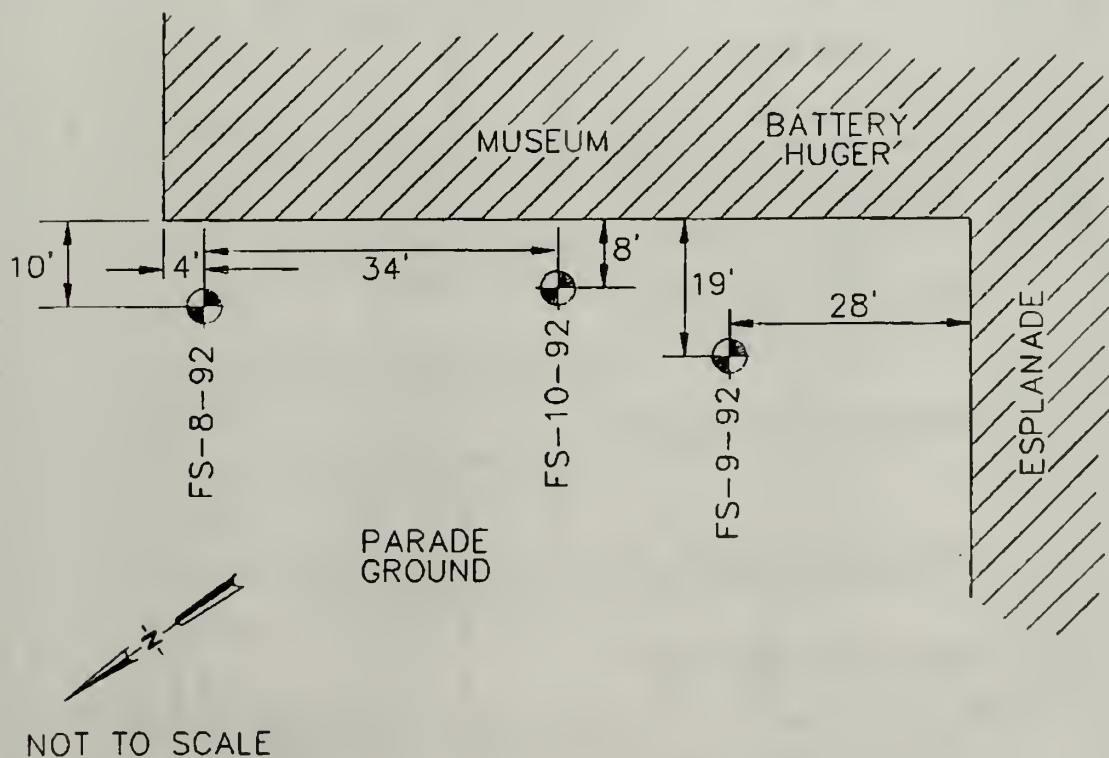
OF

3

SHEETS

a ELEVATION	b DEPTH 30	c LEGEND	d CLASSIFICATION OF MATERIALS (Description)	e % CORE RECOVERY	f BOX OR SAMPLE NO	g REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
			LOOSE GRAY FINE SAND WITH ORGANIC ODOR. (SM)		16	1-2-3
			LOOSE GRAY FINE SAND WITH SLIGHT ORGANIC CLAY LENS (SM)		17	2-3-6
			LOOSE GRAY FINE SAND WITH HIGH ORGANIC CLAY LENS AND SHELL CONTENT. (SM)		18	3-3-4
	35		VERY LOOSE GRAY FINE SAND WITH HIGH ORGANIC CLAY LENS. (SM)		19	1-1-1
			LOOSE GRAY FINE SAND WITH SLIGHT SMALL ORGANIC CLAY LENS. (SM)		20	1-2-3
			LOOSE GRAY FINE SAND WITH SLIGHT SMALL ORGANIC CLAY LENS. (SM)		21	3-3-2
	40		LOOSE GRAY FINE SAND WITH SLIGHT SMALL ORGANIC CLAY LENS CONTENT. (SM)		22	1-2-4
			LOOSE GRAY FINE SAND WITH SLIGHT SMALL ORGANIC CLAY LENS AND SHELL CONTENT. (SM)		23	3-4-5
	45					
			LOOSE GRAY FINE SAND WITH SLIGHT SMALL ORGANIC CLAY LENS AND SHELL CONTENT. (SM)		24	2-3-4
	50		MEDIUM GRAY FINE SAND WITH SLIGHT SMALL ORGANIC CLAY LENS AND SHELL CONTENT. (SM)		25	5-6-8
			MEDIUM GRAY FINE SAND WITH VERY SLIGHT ORGANIC CLAY LENS AND VERY SLIGHT SMALL DECAYED WOOD. (SM)		26	1-3-14
	55					
			VERY LOOSE GRAY FINE SAND WITH SLIGHT LARGE ORGANIC CLAY LENS (SM)		27	1-1-3
			MEDIUM GRAY FINE SAND WITH ORGANIC ODOR. (SM)		28	3-4-7
	60					
			MEDIUM GRAY FINE SAND WITH SLIGHT ORGANIC CLAY LENS. (SM)		29	3-4-5
	65		MEDIUM GRAY INORGANIC CLAY WITH SLIGHT SAND CONTENT. (CH)		30	2-2-3
			LOOSE GRAY FINE SAND WITH VERY SLIGHT SMALL ORGANIC CLAY LENS AND SHELL CONTENT. (SM)		31	2-3-6
	70					
			VERY LOOSE GRAY FINE SAND WITH VERY SLIGHT ORGANIC CLAY CONTENT. (SM)		32	1-1-3
			VERY STIFF BROWNISH GREEN CALCAREOUS CLAY WITH SIGHT SAND CONTENT. (MH) LOCALLY CALLED MARL BORING TERMINATED AT 76'6" AS DIRECTED BY MR. DOUG HOLMES.		33	1-8-11

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE	0' - 0" ASSUMED	Hole No. FS-8-92
PROJECT	BATTERY HUGER FOUNDATION INVESTIGATION	INSTALLATION	FT. SUMTER NATIONAL MONUMENT
			SHEET 3 OF 3 SHEETS

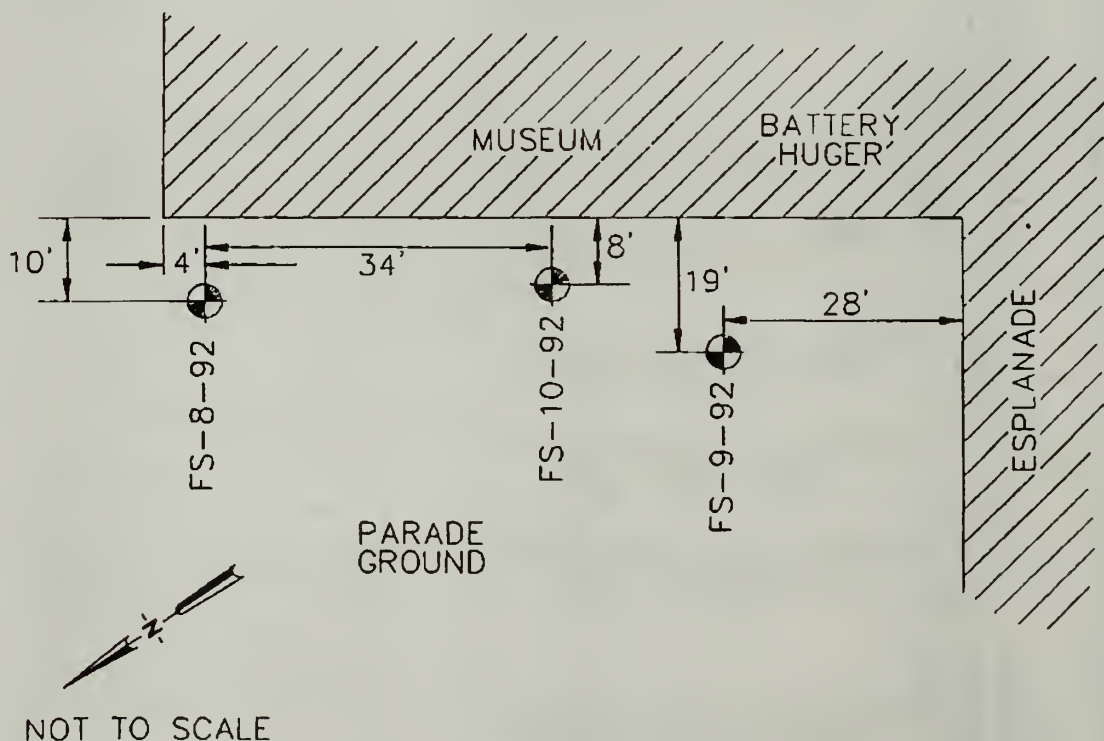


DRILLING LOG		DIVISION SOUTH ATLANTIC	INSTALLATION FT. SUMTER NATIONAL MONUMENT	SHEET or 3 SHEETS
1. PROJECT BATTERY HUGER FOUNDATION INVESTIGATION			10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station) FORT SUMTER NATIONAL MONUMENT			11. DATUM FOR ELEVATION SHOWN (TBM or MVD) NONE	
3. DRILLING AGENCY SOIL CONSULTANTS, INC.			12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number) FS-9-92			13. TOTAL NUMBER OF OVERBURDEN SAMPLES TAKEN DISTURBED 32 UNDISTURBED	
5. NAME OF DRILLER FRANK EATON			14. TOTAL NUMBER OF CORE BOXES NONE	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERTICAL			15. ELEVATION GROUND WATER 3' - 0"	
7. THICKNESS OF OVERBURDEN			16. DATE HOLE STARTED 3/23/92 COMPLETED 3/24/92	
8. DEPTH DRILLED INTO ROCK			17. ELEVATION TOP OF HOLE 0' - 0" ASSUMED	
9. TOTAL DEPTH OF HOLE 76' - 6"			18. TOTAL CORE RECOVERY FOR BORING X	
			19. SIGNATURE OF INSPECTOR	

a ELEVATION	b DEPTH 0	c LEGEND	d CLASSIFICATION OF MATERIALS (Description)	e % CORE RECOVERY	f BOX OR SAMPLE NO	g REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
			BROWN, TAN FINE SAND			AUGER BORING 0'0" TO 5'0"
	5		LOOSE GRAY FINE SAND (SM)		1	3-3-2
			LOOSE GRAY FINE SAND. (SM)		2	2-3-7
			VERY DENSE GRAY FINE SAND WITH CEMENTED MATERIAL (SM)		3	5-2-37/3"
	10		SOLID GRANITE			
			LOOSE GRANITE			
	15		LOOSE GRAY FINE SAND WITH SLIGHT ORGANIC CLAY CONTENT (SM)		4	5-4-2
			VERY LOOSE GRAY FINE SAND WITH HIGH ORGANIC CLAY CONTENT. (SC)		5	3-2-1
			MEDIUM GRAY FINE SAND WITH ORGANIC CLAY AND SHELL CONTENT (SM)		6	1-8-14
	20		DENSE GRAY FINE SAND CHANGING AT 18'-6" TO VERY LOOSE GRAY FINE SAND WITH SLIGHT ORGANIC CLAY CONTENT. (SM)		7	32-15-4
			MEDIUM GRAY FINE SAND WITH SLIGHT SHELL CONTENT. (SM)		8	8-17-11
					9	7-18-15
					10	3-3-11
	25		DENSE GRAY FINE SAND WITH VERY SLIGHT SHELL CONTENT. (SM)		11	3-8-19
					12	4-15-22
					13	6-16-18
	30		MEDIUM GRAY FINE SAND WITH VERY SLIGHT SHELL CONTENT. (SM)		14	5-7-7
			Continued on Sheet 2			BLOWS PER FOOT
			Note: Soils visually classified in accordance with Unified Soil Classification System.			Number required to drive 1-3/8" ID splitspoon 12" with 140 lb. hammer falling 30"

. DRILLING LOG (Cont. Sheet)		ELEVATION TOP OF HOLE		Hole No. FS-9-92			
PROJECT			INSTALLATION			SHEET 2 OF 3 SHEETS	
a - ELEVATION	b DEPTH 30	c LEGEND	d CLASSIFICATION OF MATERIALS (Description)	e % CORE RECOVERY	f BOX OR SAMPLE NO	g REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	
			MEDIUM GRAY FINE SAND WITH VERY SLIGHT SHELL AND ORGANIC CLAY CONTENT. (SM)		15	7-6-6	
			VERY LOOSE GRAY FINE SAND WITH SLIGHT SHELL & ORGANIC CLAY CONTENT. (SM)		16	1-2-2	
			LOOSE GRAY FINE SAND WITH SLIGHT ORGANIC CLAY & SHELL CONTENT. (SM)		17	1-1-6	
	35		VERY LOOSE GRAY FINE SAND WITH HIGH ORGANIC CLAY CONTENT. (SC)		18	2/18"	
			VERY LOOSE GRAY FINE SAND WITH VERY SLIGHT ORGANIC CLAY CONTENT. (SM)		19	1-1-2	
			MEDIUM GRAY FINE SAND WITH VERY SLIGHT SMALL ORGANIC CLAY LENS. (SM)		20	1-4-13	
	40				21	3-3-8	
			LOOSE GRAY FINE SAND WITH SLIGHT ORGANIC CLAY LENS (SM)		22	2-4-6	
	45		VERY DENSE GRAY FINE SAND. (SM)		23	20-36	
			MEDIUM GRAY FINE SAND WITH VERY SLIGHT SMALL ORGANIC CLAY LENS. (SM)		24	3-5-6	
	50		LOOSE GRAY FINE SAND WITH SLIGHT SMALL ORGANIC CLAY LENS (SM)		25	2-3-3	
			SOFT GRAY ORGANIC CLAY WITH SLIGHT SAND LENS. (OL)		26	1/12" 3/6"	
	55		LOOSE GRAY FINE SAND WITH SLIGHT ORGANIC CLAY LENS AND SHELL CONTENT (SM)		27	1-1-7	
	60		MEDIUM GRAY FINE SAND WITH SLIGHT ORGANIC CLAY AND SHELL LENS CONTENT. (SM)		28	3-5-9	
			MEDIUM GRAY FINE SAND WITH SLIGHT ORGANIC CLAY LENS AND SHELL CONTENT. (SM)		29	3-12-12	
	65		MEDIUM GRAY FINE SAND WITH HIGH SHELL AND SLIGHT ORGANIC CLAY LENS (SM)		30	14-12-14	
	70		MEDIUM BROWNISH GREEN CALCAREOUS CLAY WITH SLIGHT SAND AND SHELL CONTENT. (MH) LOCALLY CALLED MARL				

DRILLING LOG (Cont. Sheet)		ELEVATION TOP OF HOLE		Hole No. FS-9-92		
PROJECT			INSTALLATION			
			SHEET 3 OF 3 SHEETS			
a	b	c	d	e	f	g
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	75		STIFF BROWNISH GREEN CALCAREOUS CLAY WITH SLIGHT SAND CONTENT. (MH) LOCALLY CALLED MARL		32	4-5-9
	80		BORING TERMINATED AT 76'6" AS DIRECTED BY MR. DOUG HOLMES.			



DRILLING LOG		DIVISION	SOUTH ATLANTIC		INSTALLATION		FT. SUMTER NATIONAL MONUMENT		SHEET OF 3 SHEETS		
PROJECT BATTERY HUGER FOUNDATION INVESTIGATION					10. SIZE AND TYPE OF BIT						
2. LOCATION (Coordinates or Station) FORT SUMTER NATIONAL MONUMENT					11. DATUM FOR ELEVATION SHOWN (TBM or MVD) NONE						
3. DRILLING AGENCY SOIL CONSULTANTS, INC.					12. MANUFACTURER'S DESIGNATION OF DRILL						
1. HOLE NO (As shown on drawing title and file number) FS-10-92					13. TOTAL NUMBER OF OVERBURDEN SAMPLES TAKEN DISTURBED 13 UNDISTURBED						
5. NAME OF DRILLER FRANK EATON					14. TOTAL NUMBER OF CORE BOXES NONE						
					15. ELEVATION GROUND WATER 3' - 8"						
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG FROM VERTICAL					16. DATE HOLE STARTED 3/30/92 COMPLETED 3/30/92						
7. THICKNESS OF OVERBURDEN					17. ELEVATION TOP OF HOLE 0' - 0" ASSUMED						
8. DEPTH DRILLED INTO ROCK					18. TOTAL CORE RECOVERY FOR BORING X						
9. TOTAL DEPTH OF HOLE 77'					19. SIGNATURE OF INSPECTOR						

a ELEVATION	b DEPTH 0	c LEGEND	d CLASSIFICATION OF MATERIALS (Description)	e % CORE RECOVERY	f BOX OR SAMPLE NO	g REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
						AUGER BORING 0'0" TO 10'0"
	5		BROWN FINE SAND WITH BRICK FRAGMENT LOOSE GRAY FINE SAND WITH ONE SMALL ORGANIC CLAY LENS. (SM)			
	10				1	1-2-6
	15					
	20		DENSE GRAY FINE SAND WITH VERY SLIGHT SAND & ORGANIC ORDR. (SM)		2	5-13-21
	25		DENSE GRAY FINE SAND WITH SLIGHT SAND CONTENT. (SM)		3	8-15-31
	30		MEDIUM GRAY FINE SAND WITH MEDIUM SHELL CONTENT (SM WITH SHELL)		4	9-11-6
			MEDIUM GRAY FINE SAND WITH SLIGHT SHELL & VERY SLIGHT SMALL ORGANIC CLAY LENS. (SM)		5	6-11-12
			Continued on Sheet 2 Note Soils visually classified in accordance with Unified Soil Classification System.			BLOWS PER FOOT Number required to drive 1-3/8" ID splitspoon 12" with 140 lb. hammer falling 30".

DRILLING LOG (Cont. Sheet)		ELEVATION TOP OF HOLE		0' - 0" ASSUMED		Hole No. FS-10-92	
PROJECT BATTERY HUGER FOUNDATION INVESTIGATION			INSTALLATION FT. SUMTER NATIONAL MONUMENT			SHEET 2 OF 3 SHEETS	
a. ELEVATION	b. DEPTH 30	c. LEGEND	d. CLASSIFICATION OF MATERIALS (Description)	e. % CORE RECOVERY	f. BOX OR SAMPLE NO.	g. REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	
			LOOSE GRAY FINE SAND WITH HIGH 1/8" ORGANIC CLAY LENS AND SOME 1" ORGANIC CLAY LENS.		6		
	35						
			3/4 SHELBY TUBE 3" X 30" PUSHED - 24" RECOVERY - 19"		6A	PUSHED	
	40		LOOSE GRAY FINE SAND WITH HIGH SMALL ORGANIC CLAY LENS. (SM)		7	3-3-3	
			MEDIUM GRAY FINE SAND WITH SLIGHT SHELL, HIGH SMALL 1/8" TO 1/4" ORGANIC CLAY LENS AND ONE SMALL PIECE OF DECAYED WOOD CONTENT. (SM)		8	2-6-7	
	45						
	50		VERY LOOSE GRAY FINE SAND WITH HIGH SMALL 1/8" ORGANIC CLAY LENS (SM)		9	1/11" - 1/1" - 2/6"	
			MEDIUM GRAY FINE SAND WITH VERY SLIGHT SMALL 1/8" ORGANIC CLAY LENS. (SM)		10	4-8-12	
	55						
	60		MEDIUM GRAY FINE SAND WITH SLIGHT SHELL AND VERY SLIGHT SMALL 1/8" ORGANIC CLAY LENS (SM)		11	12-14-11	
			SHELBY TUBE 3" X 30" PUSHED - 24" RECOVERED - 24"		11A	PUSHED	
	65		SHELBY TUBE 3" X 30" PUSHED - 24" RECOVERED - 22"		11B	PUSHED	
			SHELBY TUBE 3" X 30" PUSHED - 24" RECOVERED - 24"		11C	PUSHED	
	70		MEDIUM GRAY FINE SAND WITH HIGH SMALL 1/8" ORGANIC CLAY LENS (SM)		12	3-5-9	
			SHELBY TUBE 3" X 30" PUSHED - 24" RECOVERED - 24" (CALCAREOUS CLAY)		13	PUSHED	

CONTRACT NO. DACW60-92-M-0135

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE

0' - 0" ASSUMED

Hole No. FS-10-92

PROJECT

BATTERY HUGER
FOUNDATION INVESTIGATION

INSTALLATION

FT. SUMTER NATIONAL MONUMENT

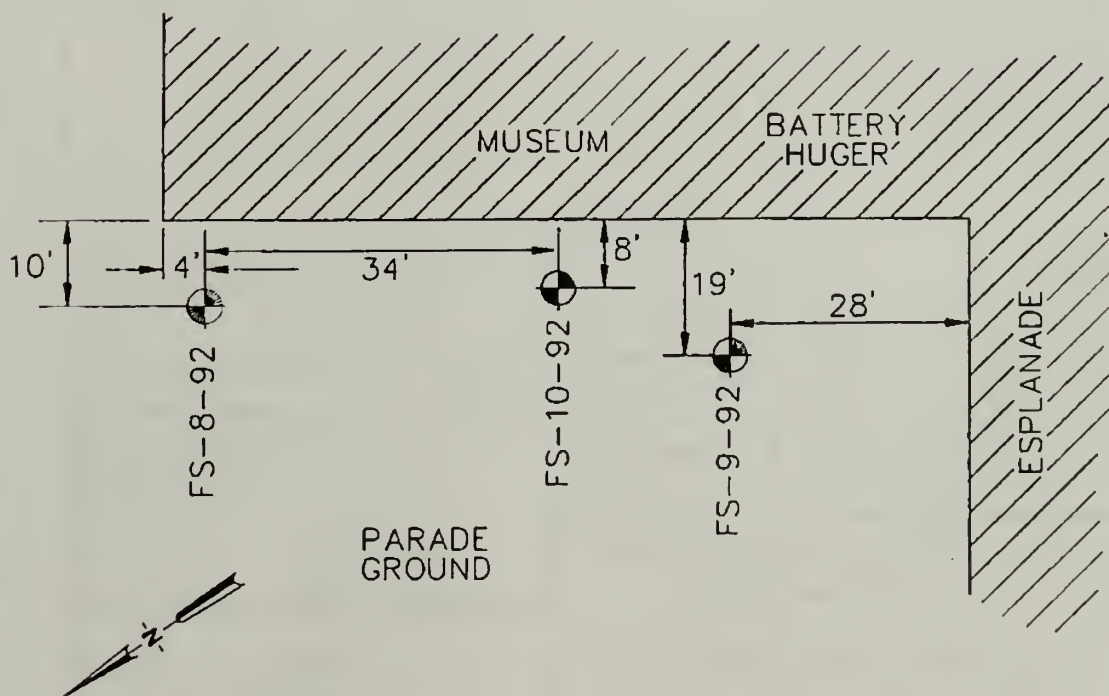
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3

OF

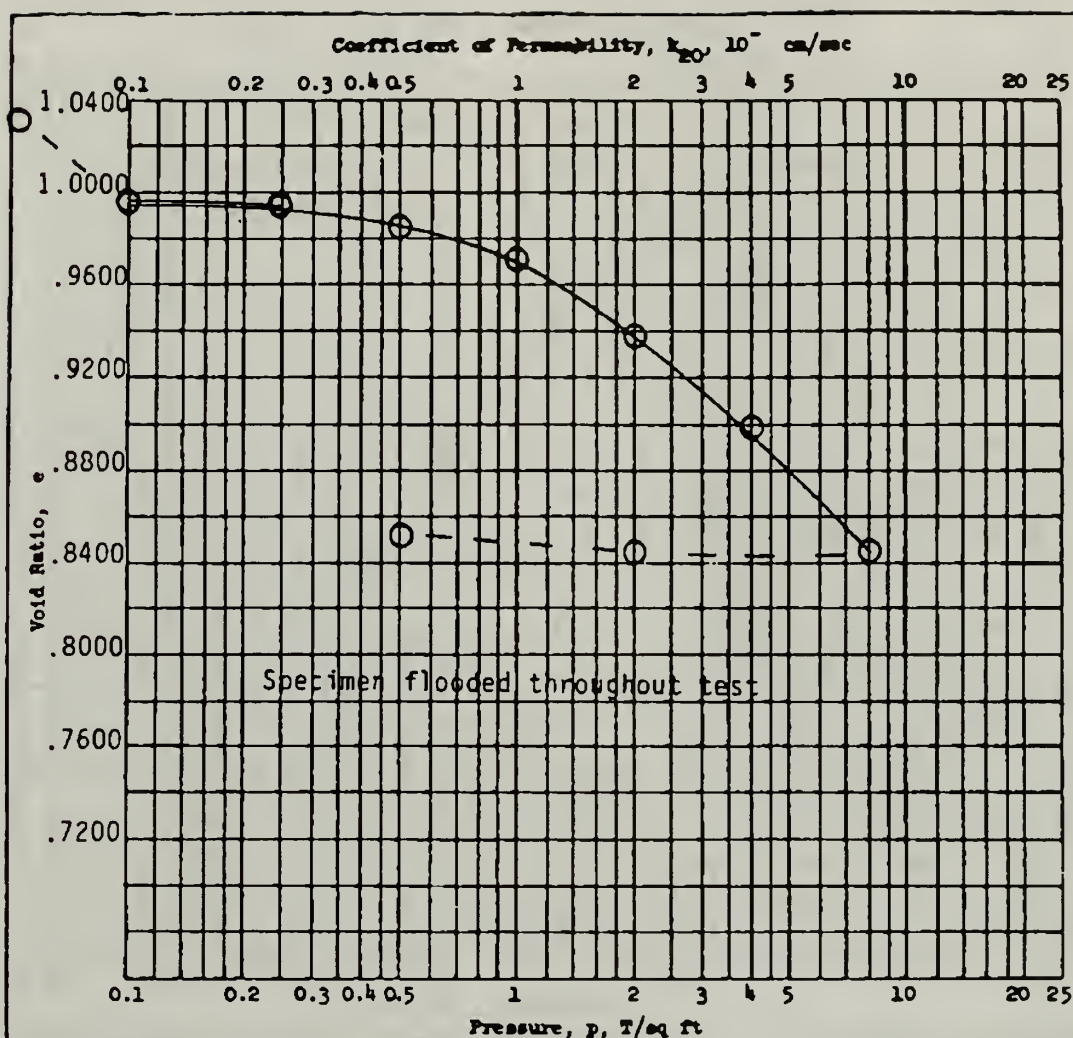
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SHEETS



NOT TO SCALE

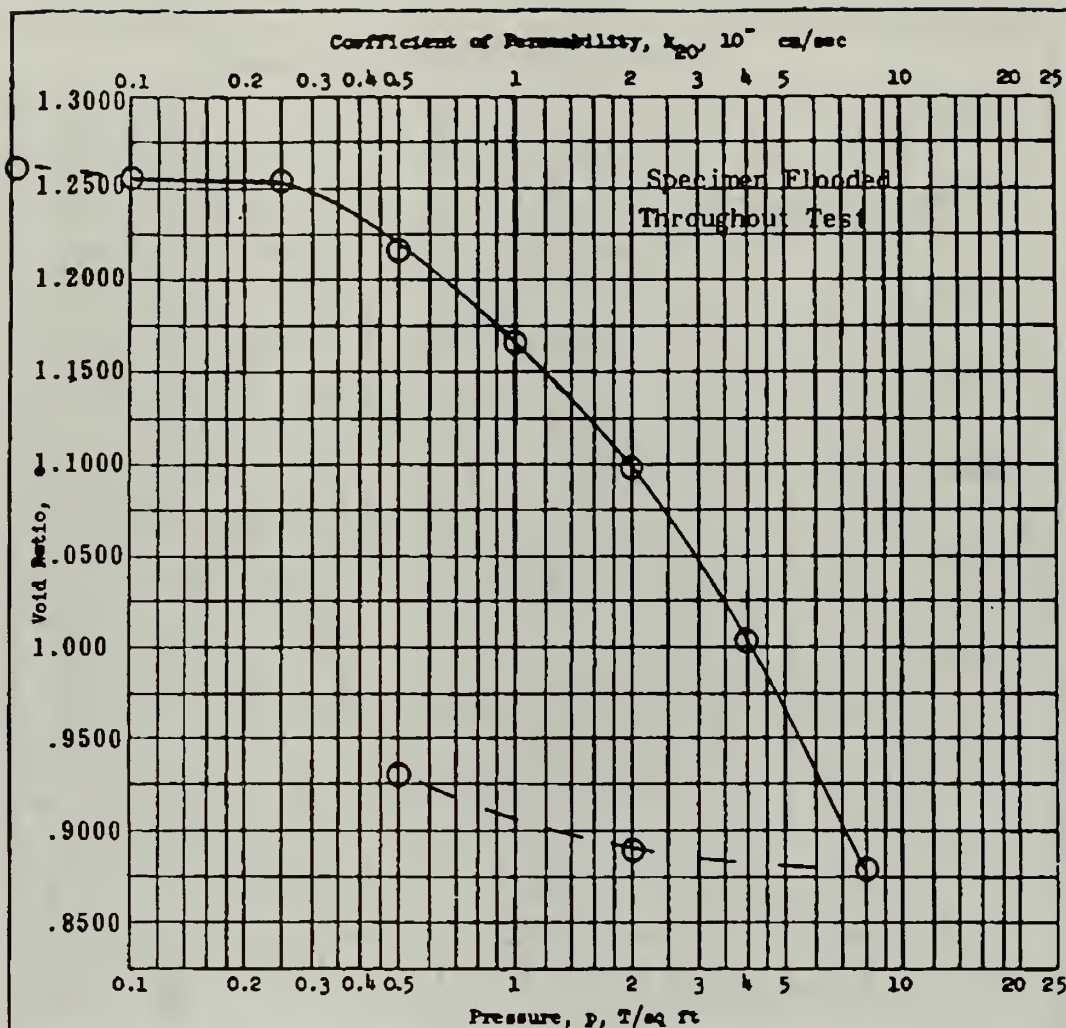
LABORATORY TEST RESULTS
CONSOLIDATION TESTS



Type of Specimen undisturbed		Before Test		After Test	
Diam 2.49 in.	Ht 1.00 in.	Water Content, w_o	38.3 %	w_f	31.7 %
Overburden Pressure, p_o T/eq ft		Void Ratio, e_o	1.031	e_f	.851
Preconsol. Pressure, p_c T/eq ft		Saturation, S_o	100.0 %	S_f	100.0 %
Compression Index, C_c		Dry Density, γ_d	82.7 lb/ft ³		
Classification		k_{20} at e_o = $\times 10^{-7}$ cm/sec			
LL 29	q_u 2.69	Project Ft. Sumter National Monument			
FL 22	D_{10} .0057mm				
Remarks See gradation curve		Area Battery Huger Investigation			
on ENG Form 2087.		Boring No. FS-10-92		Sample No. 6A	
		Depth 36.5-38.5'		Date 14 May 92	
		CONSOLIDATION TEST REPORT			

WORK ORDER NO. 6636
REQ. NO. SACRM-92-84

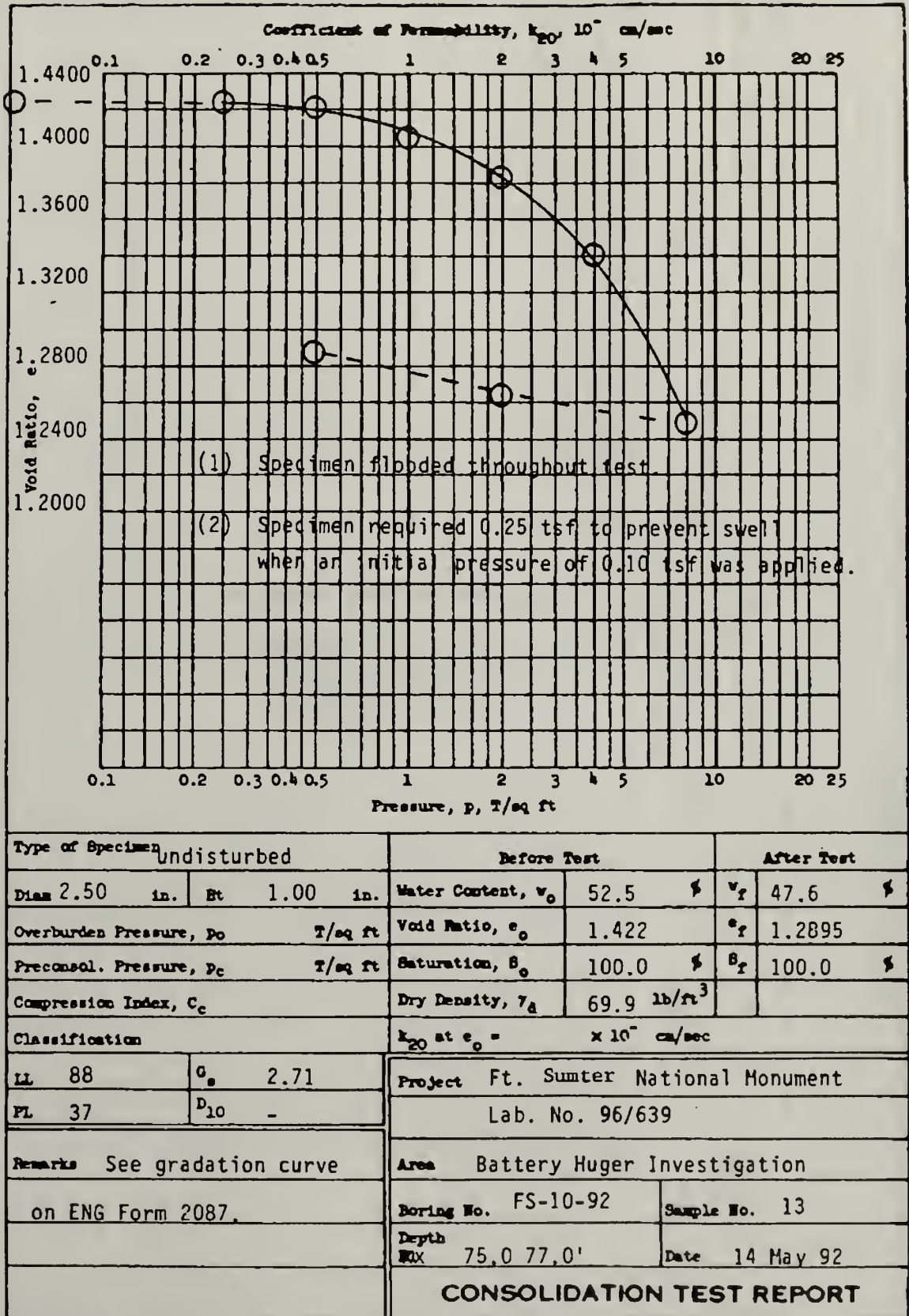
DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061



Type of Specimen		Undisturbed		Before Test		After Test	
Diam	2.50 in.	Ht	1.00 in.	Water Content, w_0	45.8 %	w_f	34.4 %
Overburden Pressure, P_0 T/sq ft				Void Ratio, e_0	1.255	e_f	.928
Preconsol. Pressure, P_c T/sq ft				Saturation, S_0	98.5 %	S_f	100.0 %
Compression Index, C_c				Dry Density, γ_d	74.7 lb/ft ³		
Gray, clayey sand high LL classification (SC-H)				k_{20} at e_0 = $\times 10^{-7}$ cm/sec			
LL	55	G_s	2.70	Project Ft. Sumter National Monument Charleston, SC			
PL	22	D_{10}	<0.002MM	Lab. No. 96/637			
Remarks See gradation curve				Area Battery Huger Investigation			
on ENG Form 2087.				Boring No. FS-10-92		Sample No. 118	
				Depth 64.0-66.0'		Date 20 May 1992	
				CONSOLIDATION TEST REPORT			

WORK ORDER NO. 5636
SACRH-92-84
REQ. NO.

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061



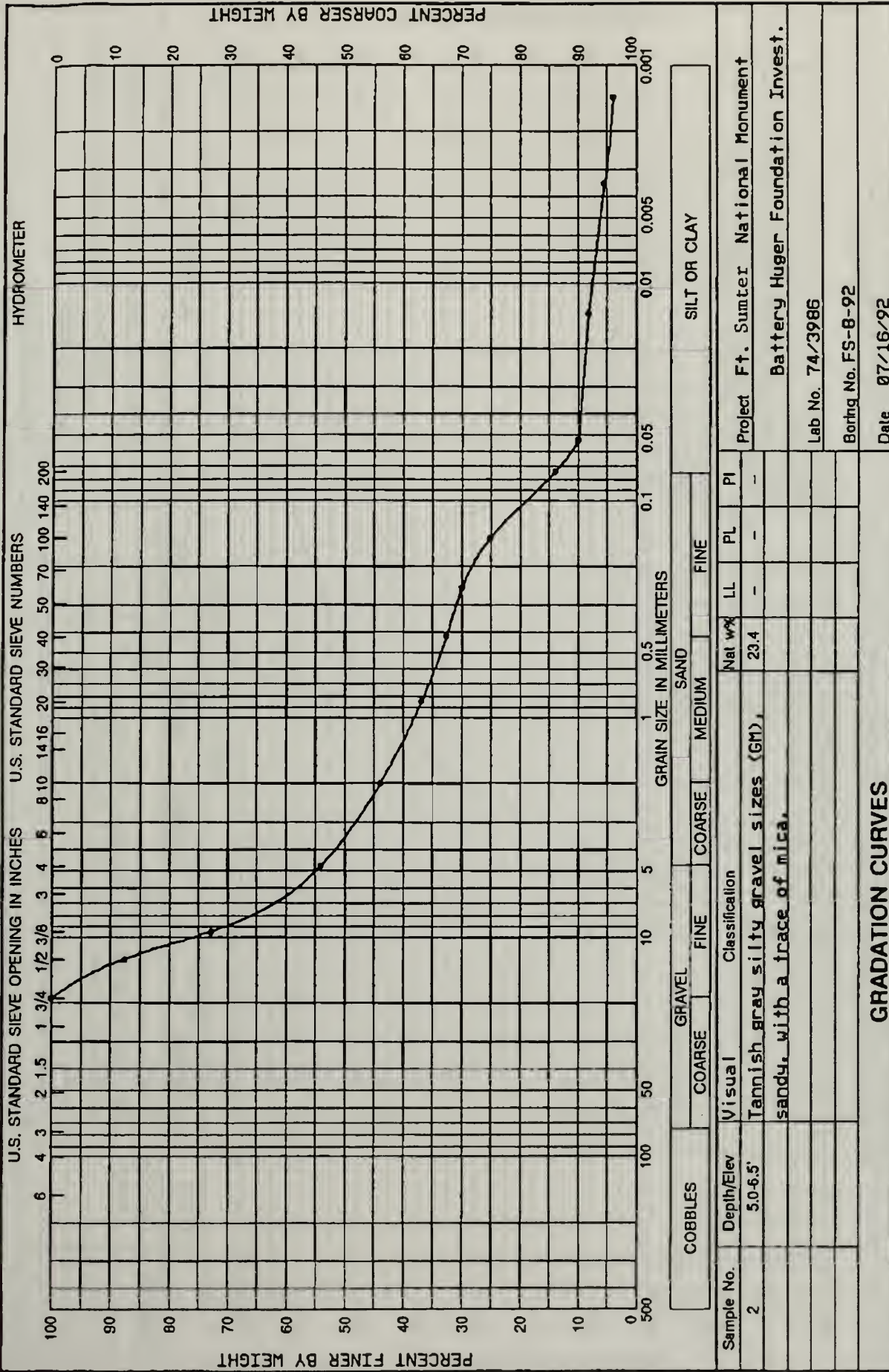
Type of Specimen		Undisturbed		Before Test		After Test	
Diam	2.50 in.	Ht	1.00 in.	Water Content, w_o	52.5 %	w_f	47.6 %
Overburden Pressure, P_o		T/sq ft		Void Ratio, e_o	1.422	e_f	1.2895
Preconsol. Pressure, P_c		T/sq ft		Saturation, S_o	100.0 %	S_f	100.0 %
Compression Index, C_c				Dry Density, γ_d	69.9 lb/ft ³		
Classification				k_{20} at e_o = $\times 10^{-10}$ cm/sec			
LL	88	U_o	2.71	Project Ft. Sumter National Monument			
PL	37	D_{10}	-	Lab. No. 96/639			
Remarks See gradation curve				Area Battery Huger Investigation			
on ENG Form 2087.				Boring No. FS-10-92		Sample No. 13	
				Depth BOX 75.0 77.0'		Date 14 May 92	
				CONSOLIDATION TEST REPORT			

LABORATORY TEST RESULTS

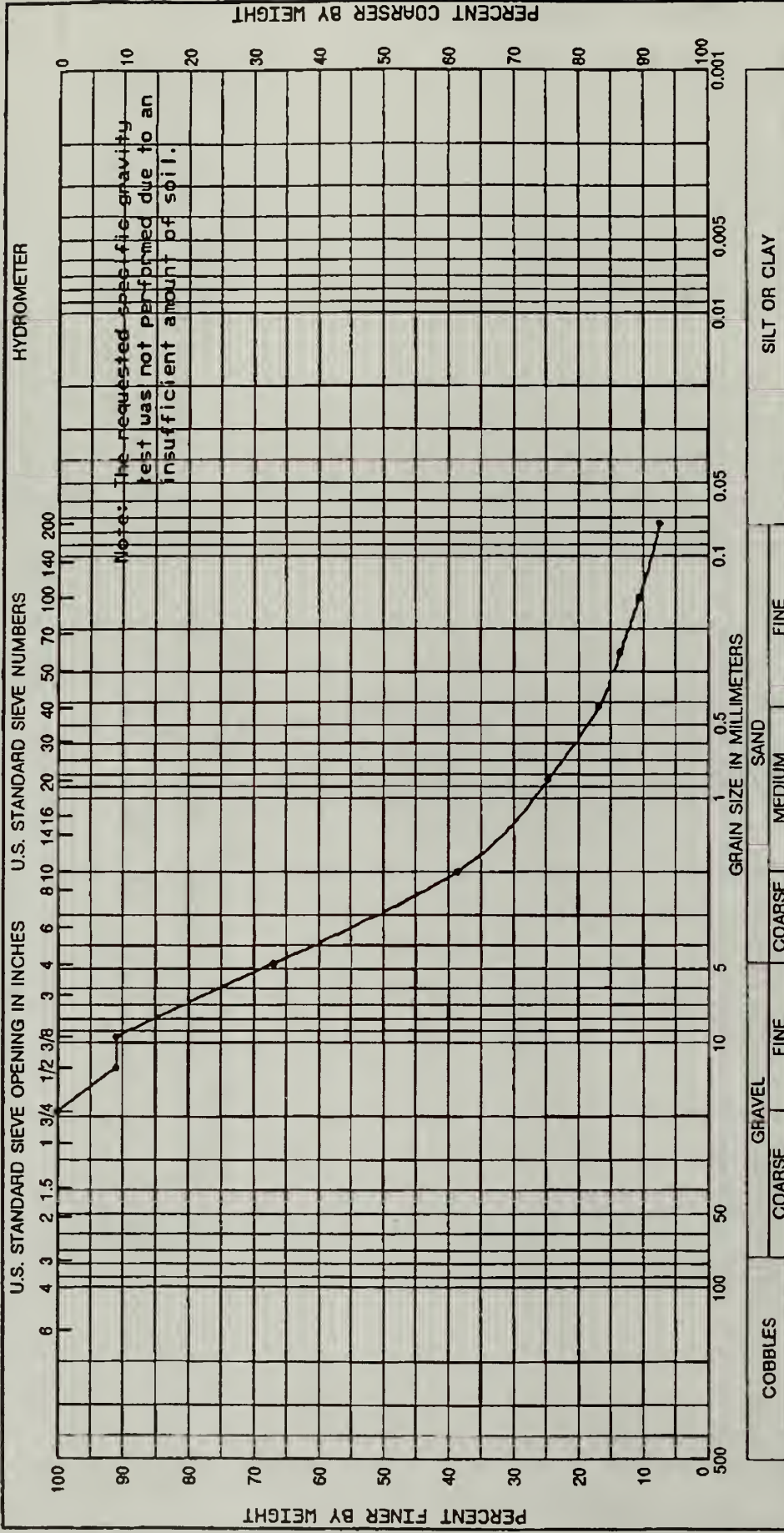
**GRADATION CURVES
ATTERBERG LIMITS
MOISTURE CONTENT
SPECIFIC GRAVITY**

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER: 6636
REQUISITION: SACRM-92-84

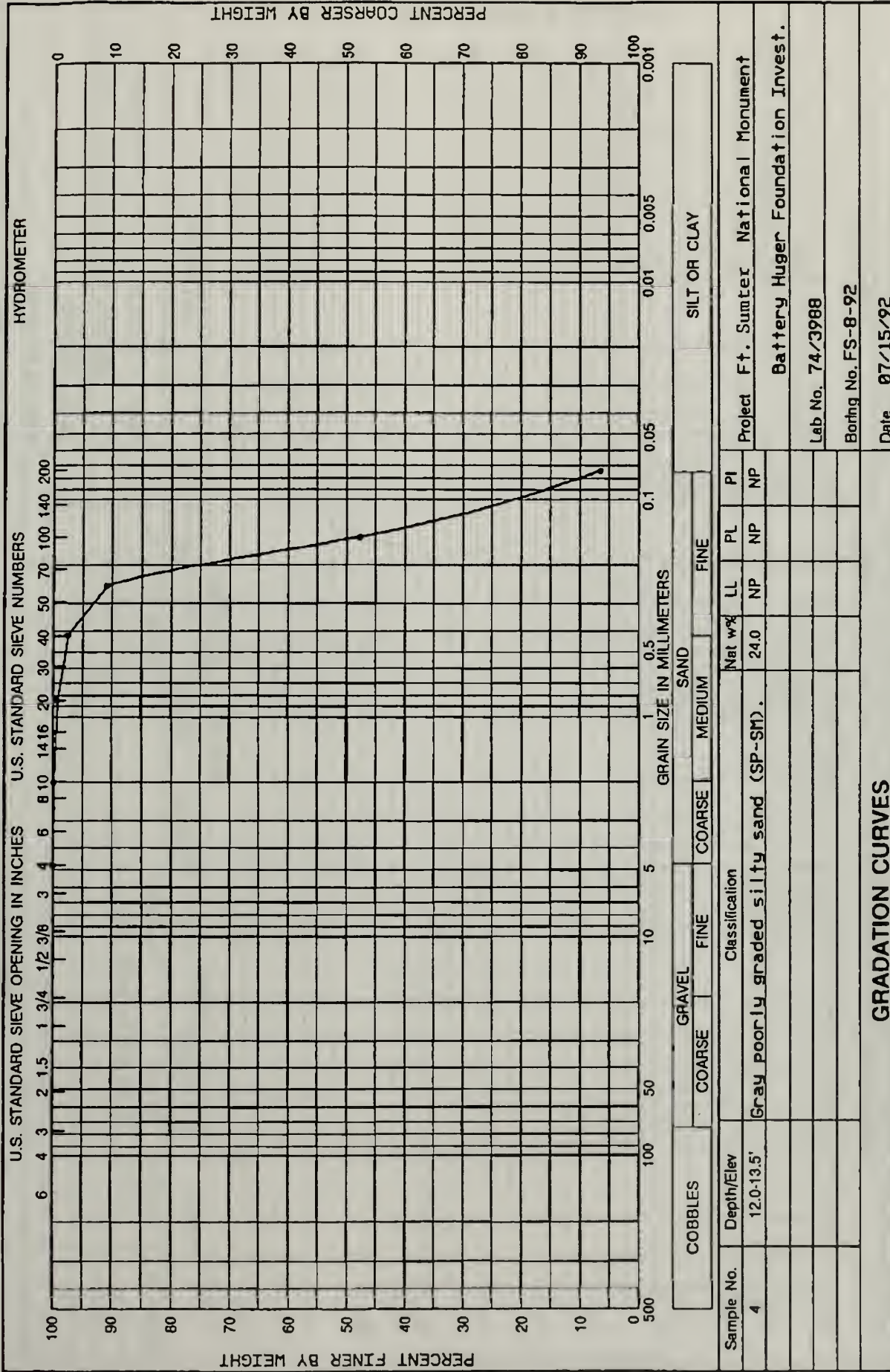


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REQUISITION: SACRM-92-84

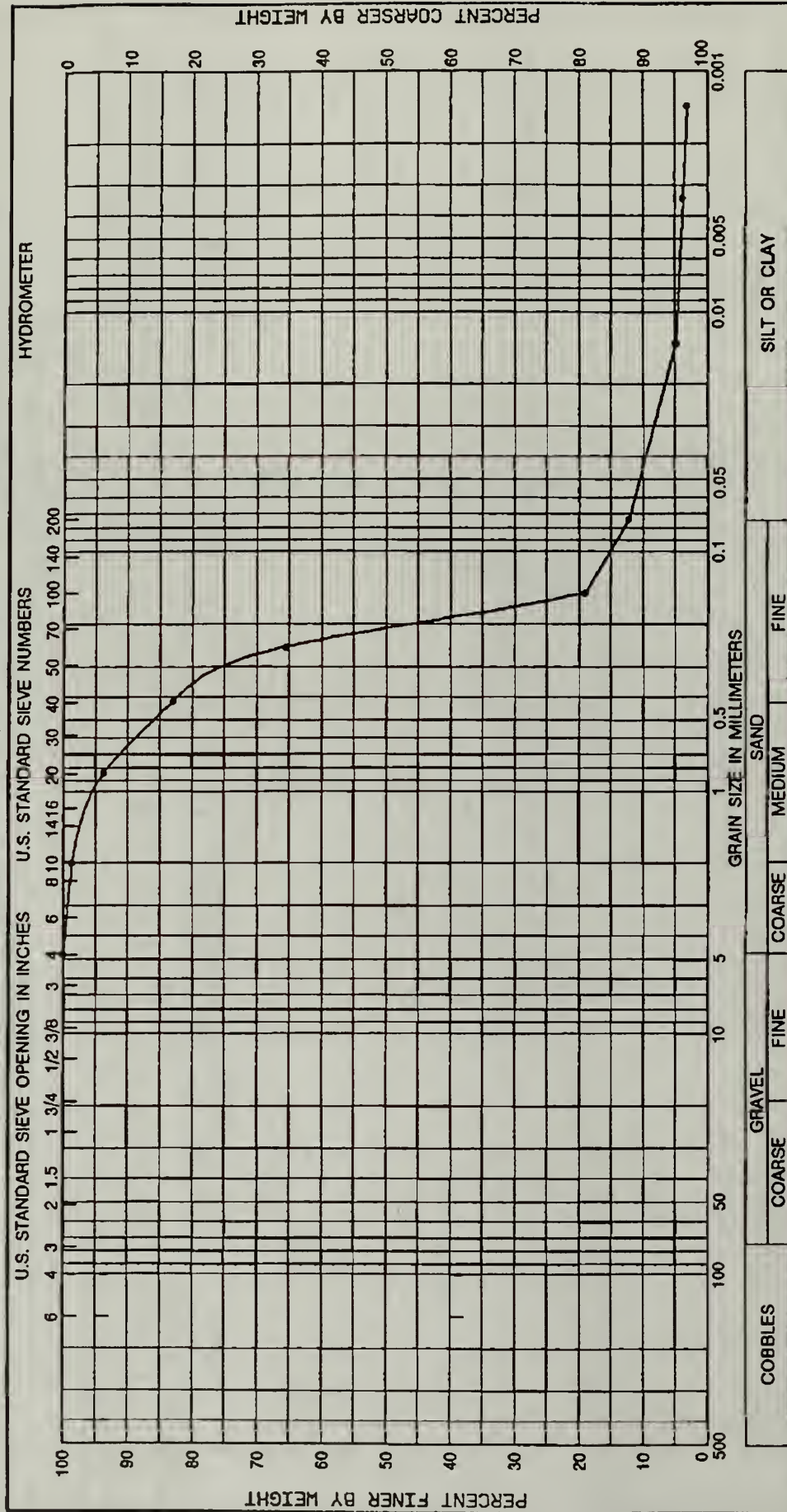
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DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER: 6636
REQUISITION: SACRM-92-84



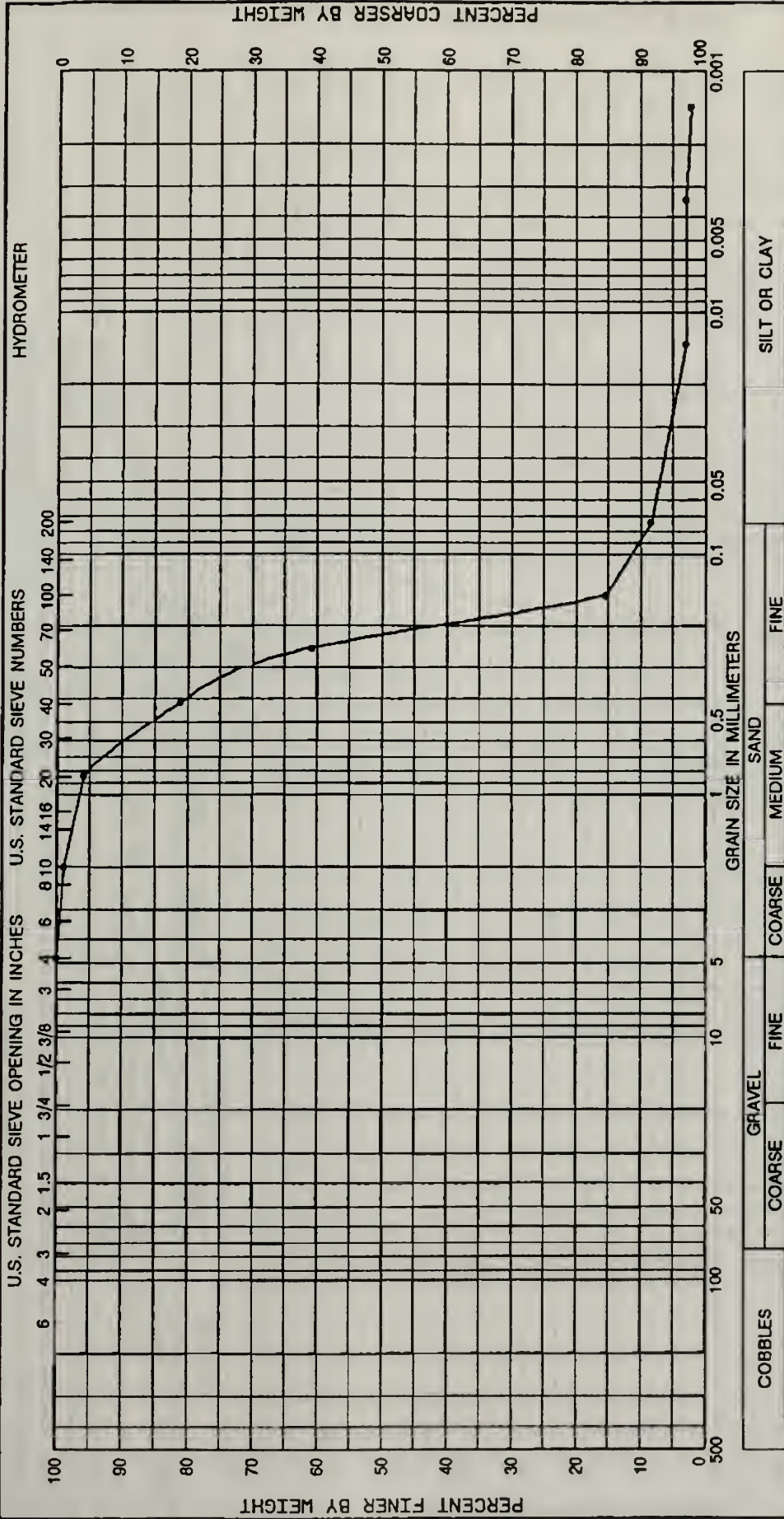
WORK ORDER: 6636
REQUISITION: SACRM-92-84



Sample No.	Depth/Elev	Visual	Classification	Nat w%	LL	PL	PI	Project	Ft. Sumter	National Monument
5	13.5-15.0'	Gray silty sand (SM).		15.8	-	-	-	Battery Huger Foundation Invest.		
								Lab No. 74/3989		
								Boring No. FS-8-92		
								Date	07/18/92	

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WORK ORDER: 6636
REQUISITION: SACRM-92-84



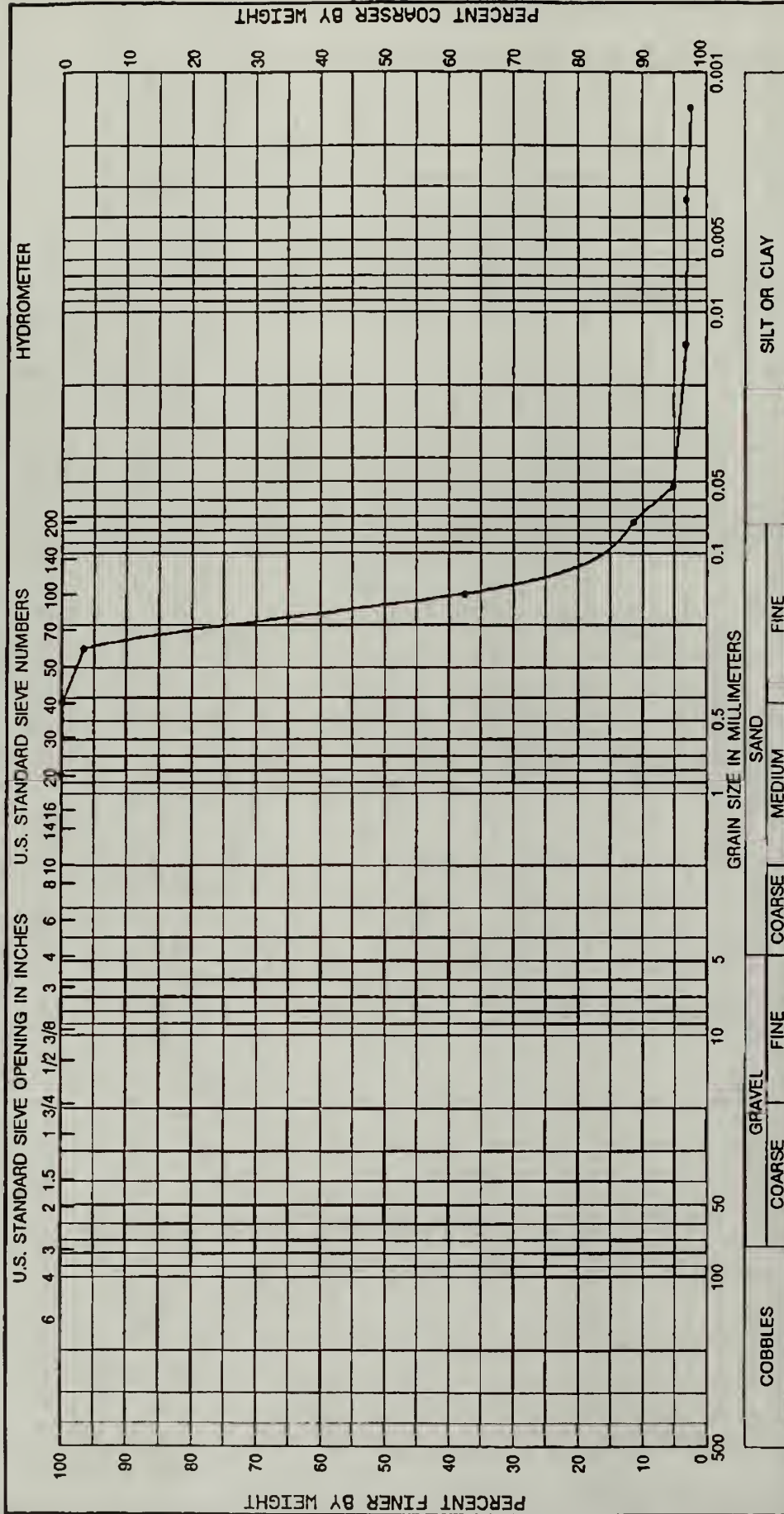
Sample No.	Depth/Elev	Visual	Classification	Nat w%	LL	PL	PI	Project	Ft. Sumter	National Monument
10	21.0-22.5'	Gray poorly graded silty sand (SP-SM).		18.5	--	--	--			
										Battery Huger Foundation Invest.
								Lab No.	74/3991	
								Boring No.	FS-8-92	
								Date	07/16/92	

GRADATION CURVES

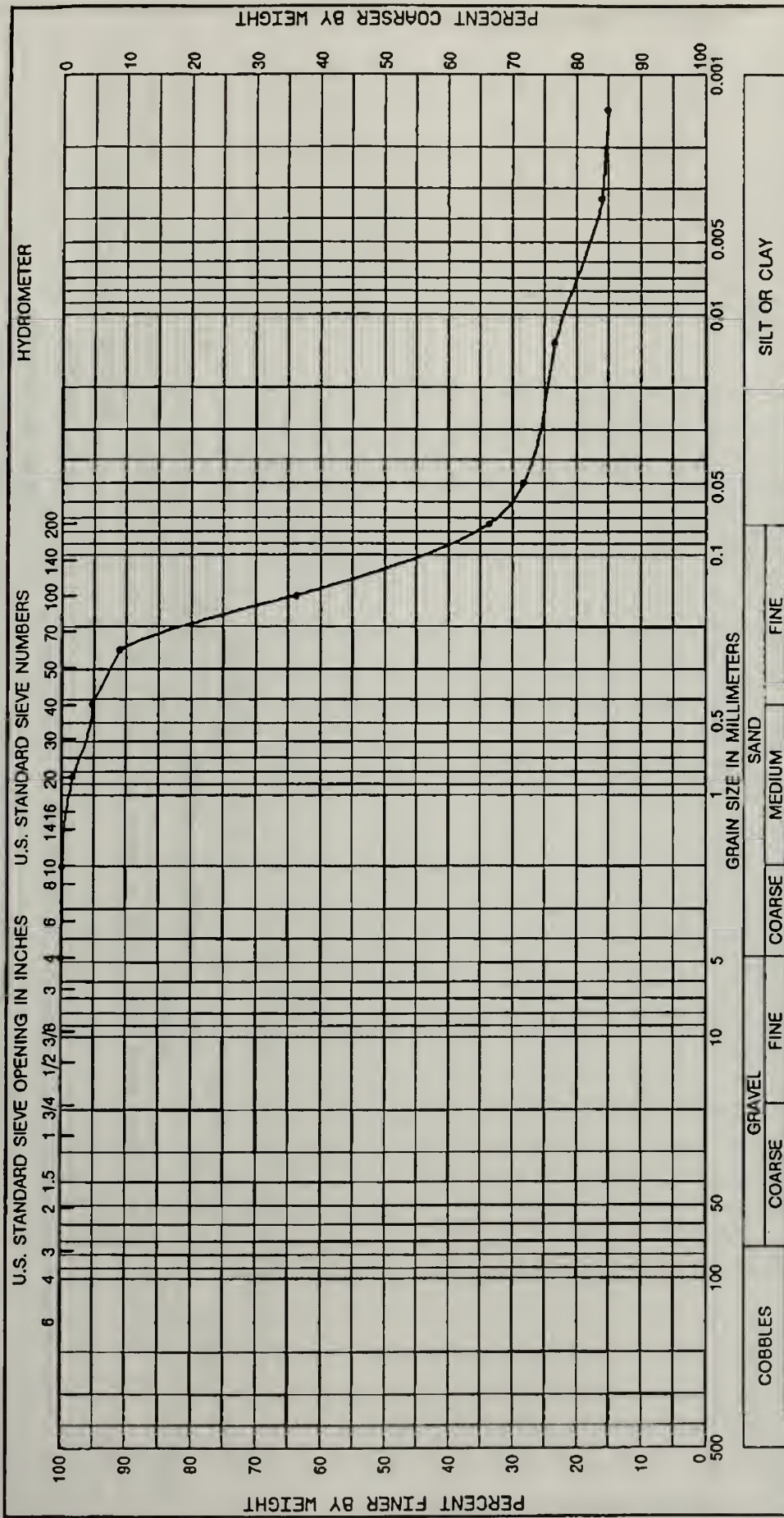


DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER: 6636
REQUISITION: SACRM-92-84



WORK ORDER: 6636
REQUISITION: SACRM-92-84



Sample No.	Depth/Elev	Classification	Nat w%	LL	PL	PI
18	33.0-34.5'	Gray clayey sand (SC), with a trace of mica.	47.6	47	21	26
		Specific Gravity = 2.67				

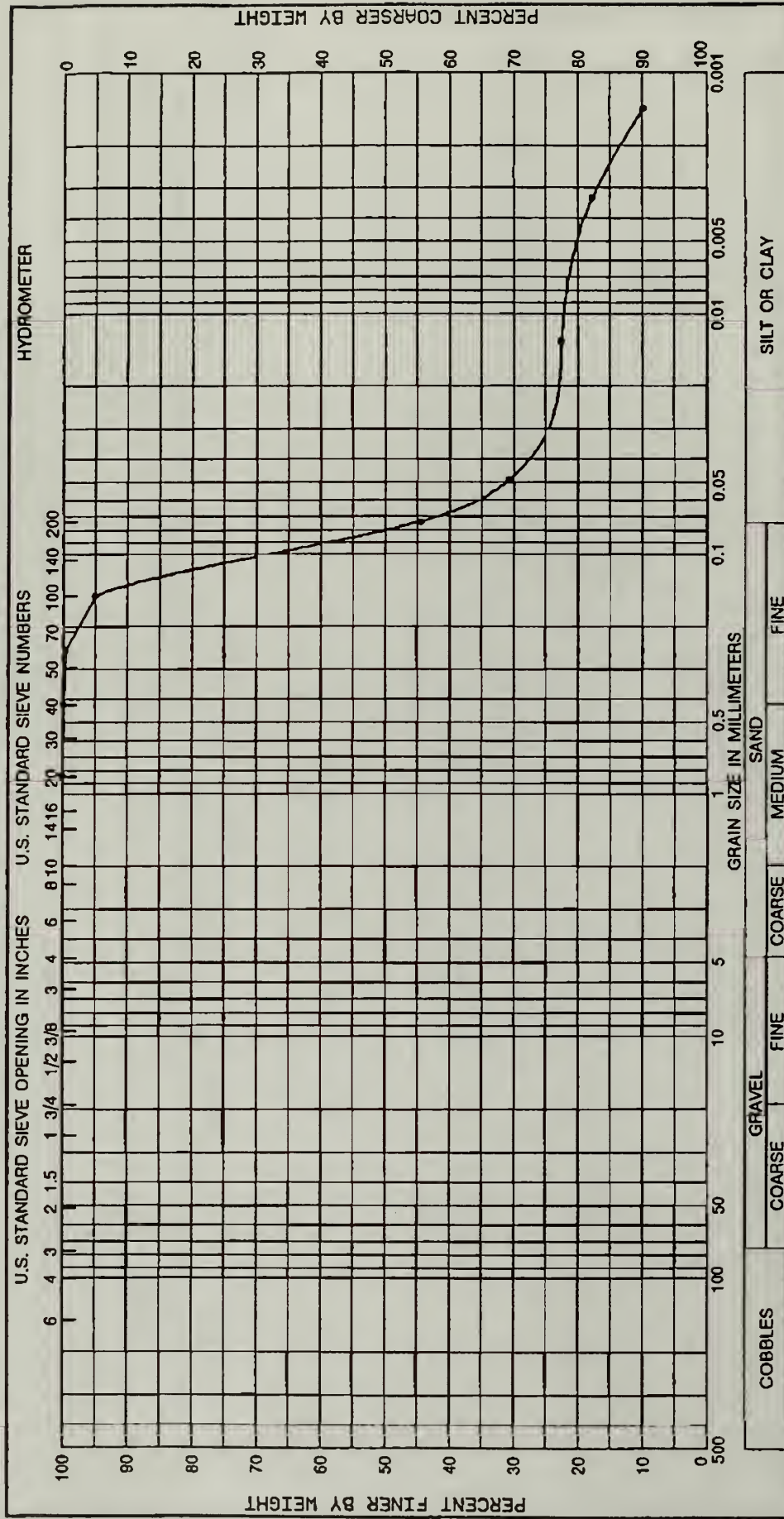
GRADATION CURVES

Project	Ft. Sumter National Monument
Battery Huger Foundation Invest.	
Lab No.	74/3993
Boring No.	FS-8-92
Date	07/15/92



DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER: 6636
REQUISITION: SACRM-92-84

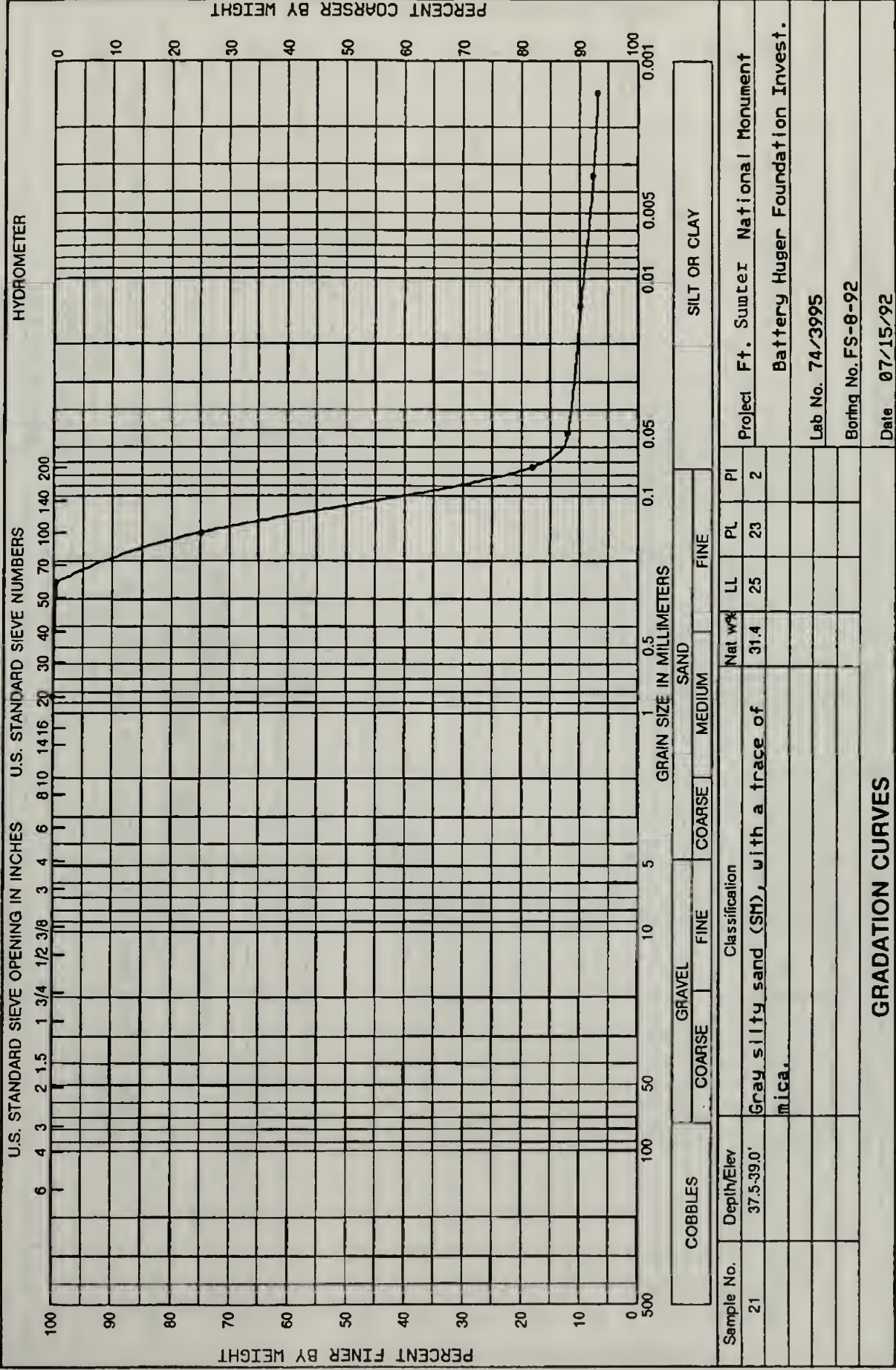
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DEPARTMENT OF THE ARMY SOUTH ATLANTIC DIVISION LABORATORY

WORK ORDER: 6636

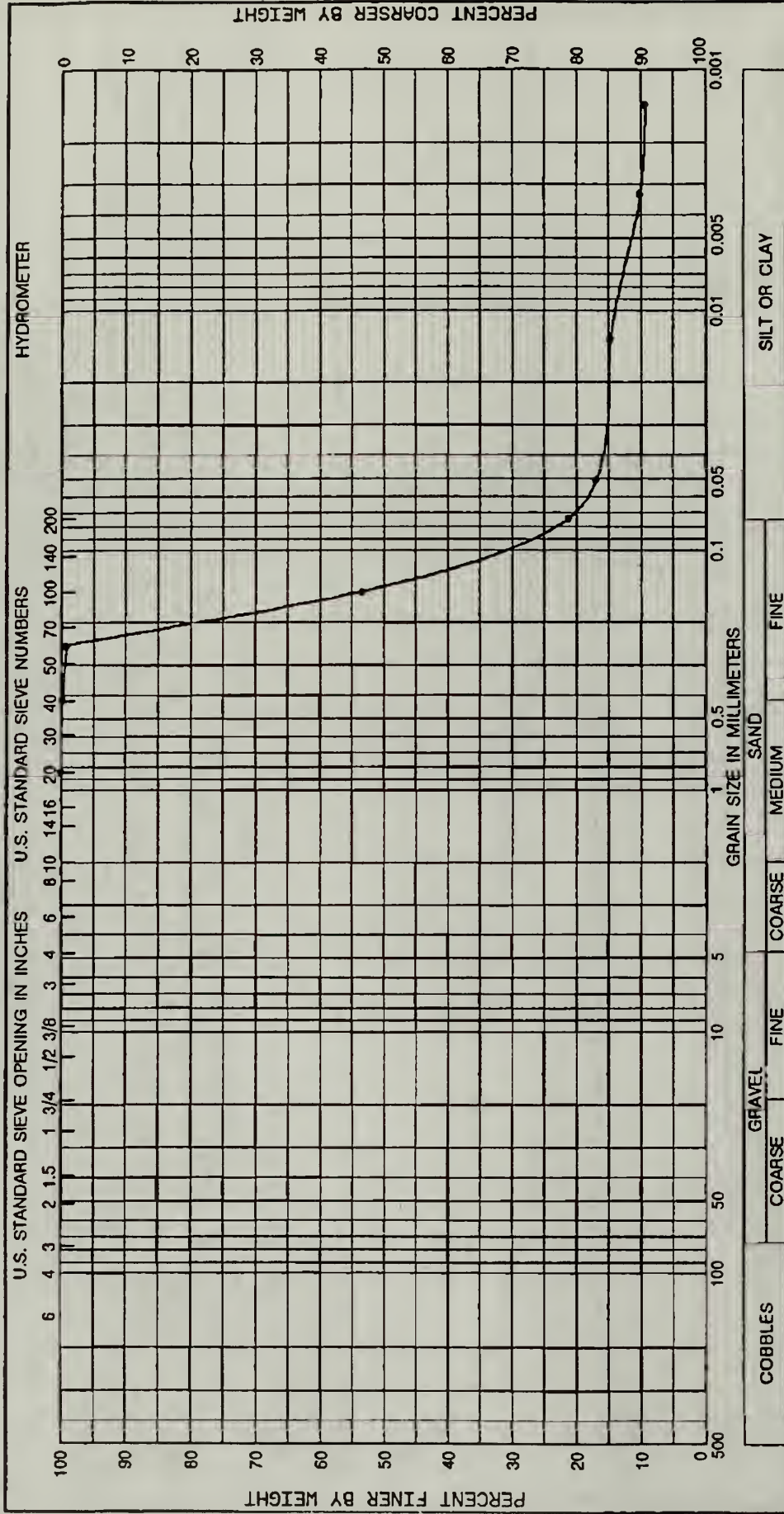
DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER: 6636
REQUISITION: SACRM-92-84



GRADATION CURVES



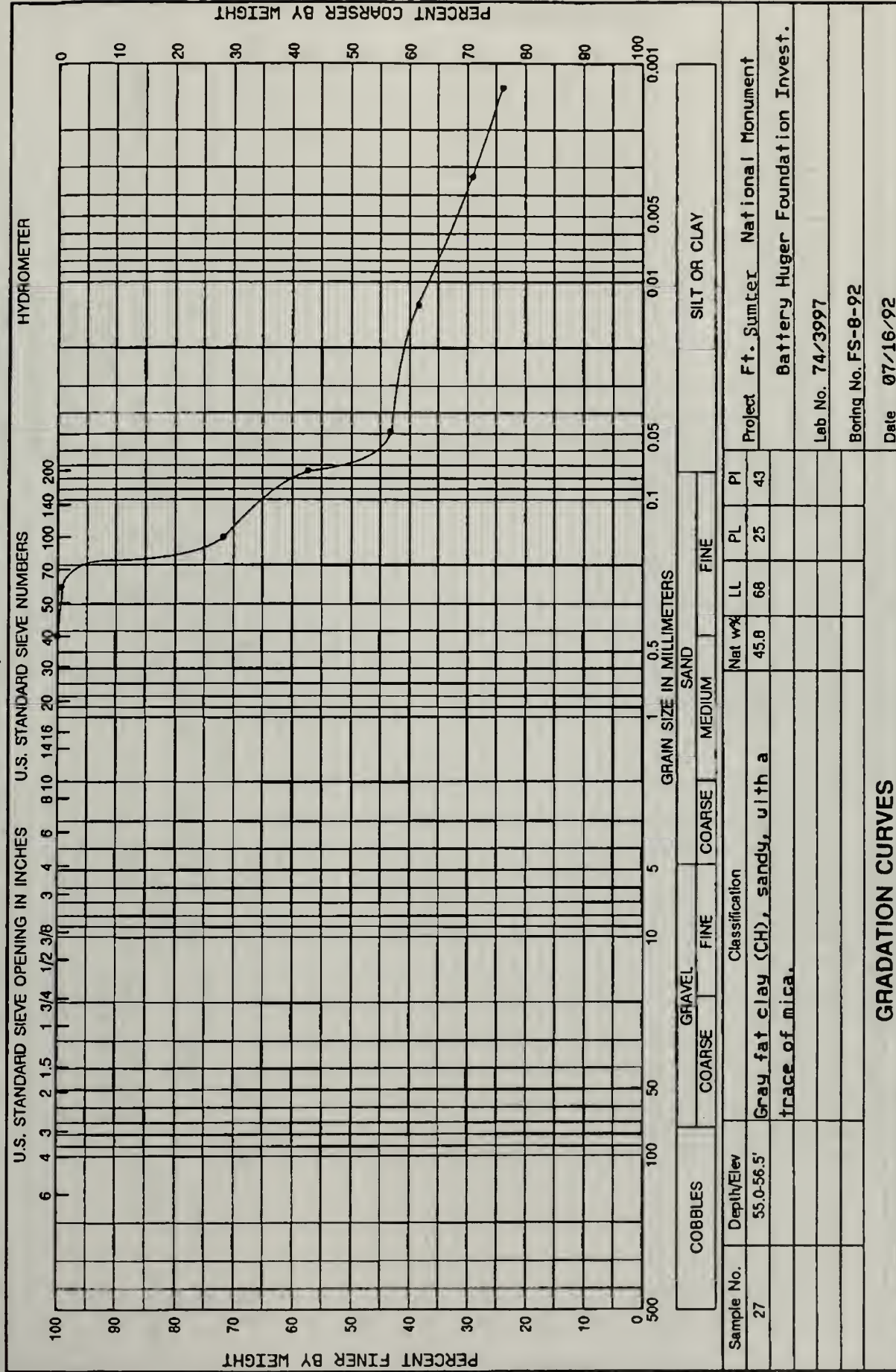


Sample No.	Depth/Elev	Classification	Net w%	LL	PL	PI
25	49.0-50.5'	Gray clayey sand (SC), with a trace of mica.	36.1	30	20	10
GRADATION CURVES						
Project Ft. Sumter National Monument						
Battery Huger Foundation Invest.						
Lab No. 74/3996						
Boring No. FS-8-92						
Date 07/15/92						

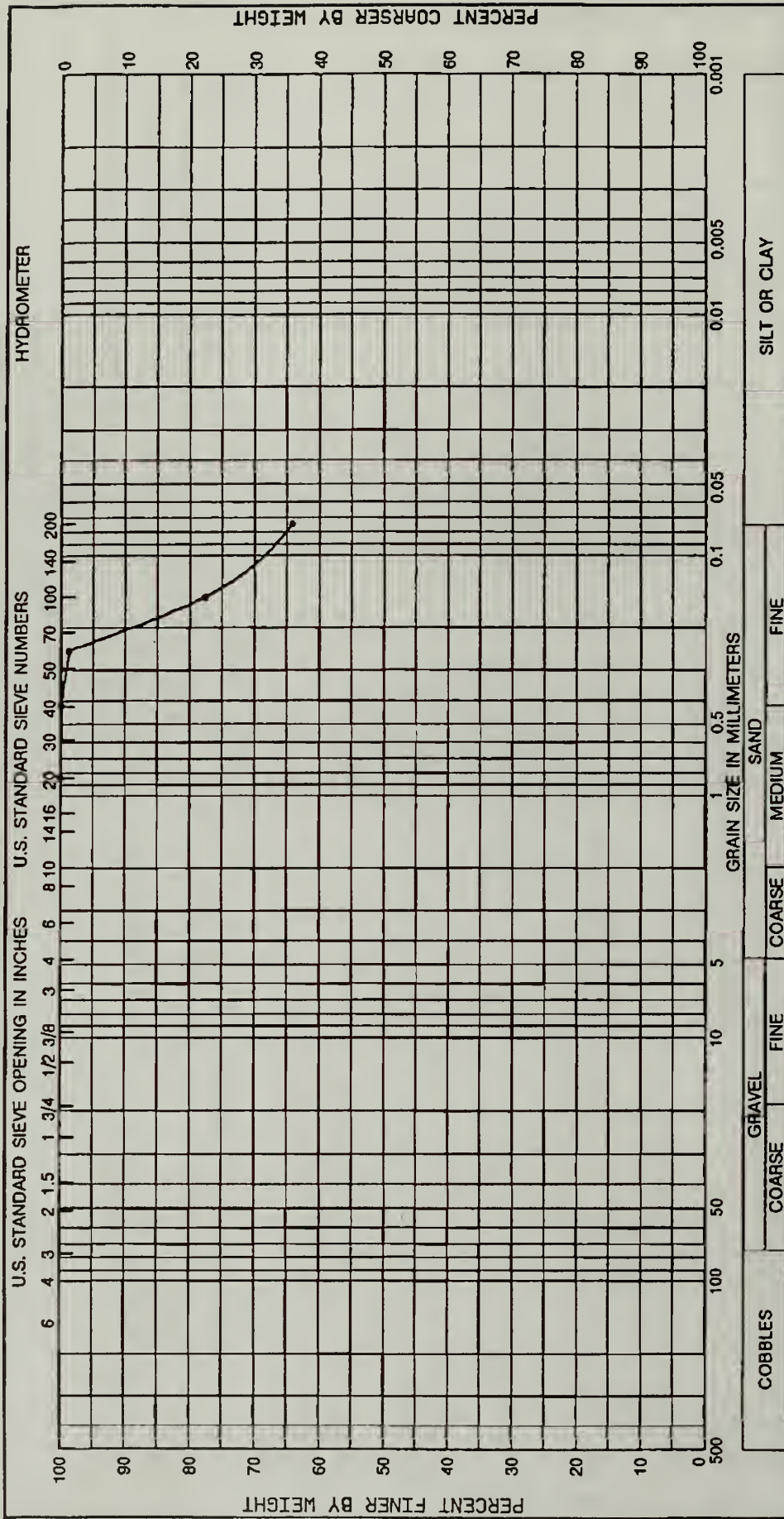


DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

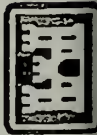
WORK ORDER: 6636
REQUISITION: SACRM-92-84



WORK ORDER: 6636
REQUISITION: SACRM-92-84

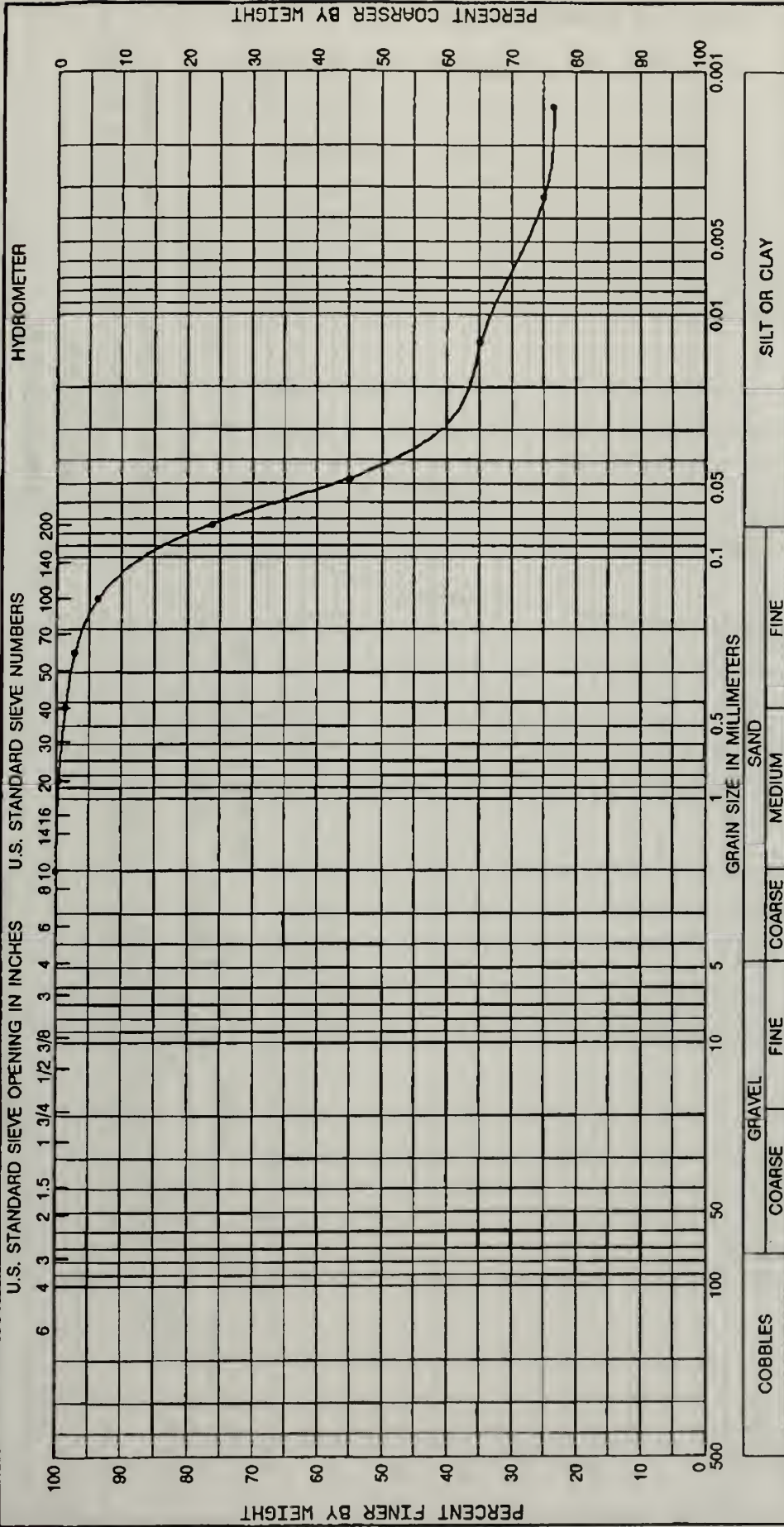


Sample No.	Depth/Elev	Classification	Nat w%	LL	PL	PI
30	64.0-65.5'	Gray fat clay (CH), sandy, with a trace of mica.	3.7	65	25	40
		Specific Gravity = 2.69				
GRADATION CURVES						
Project	Ft. Sumter	National Monument				
	Battery Huger Foundation Invest.					
Lab No.	74/3999					
Boring No.	FS-8-92					
Date	07/15/92					

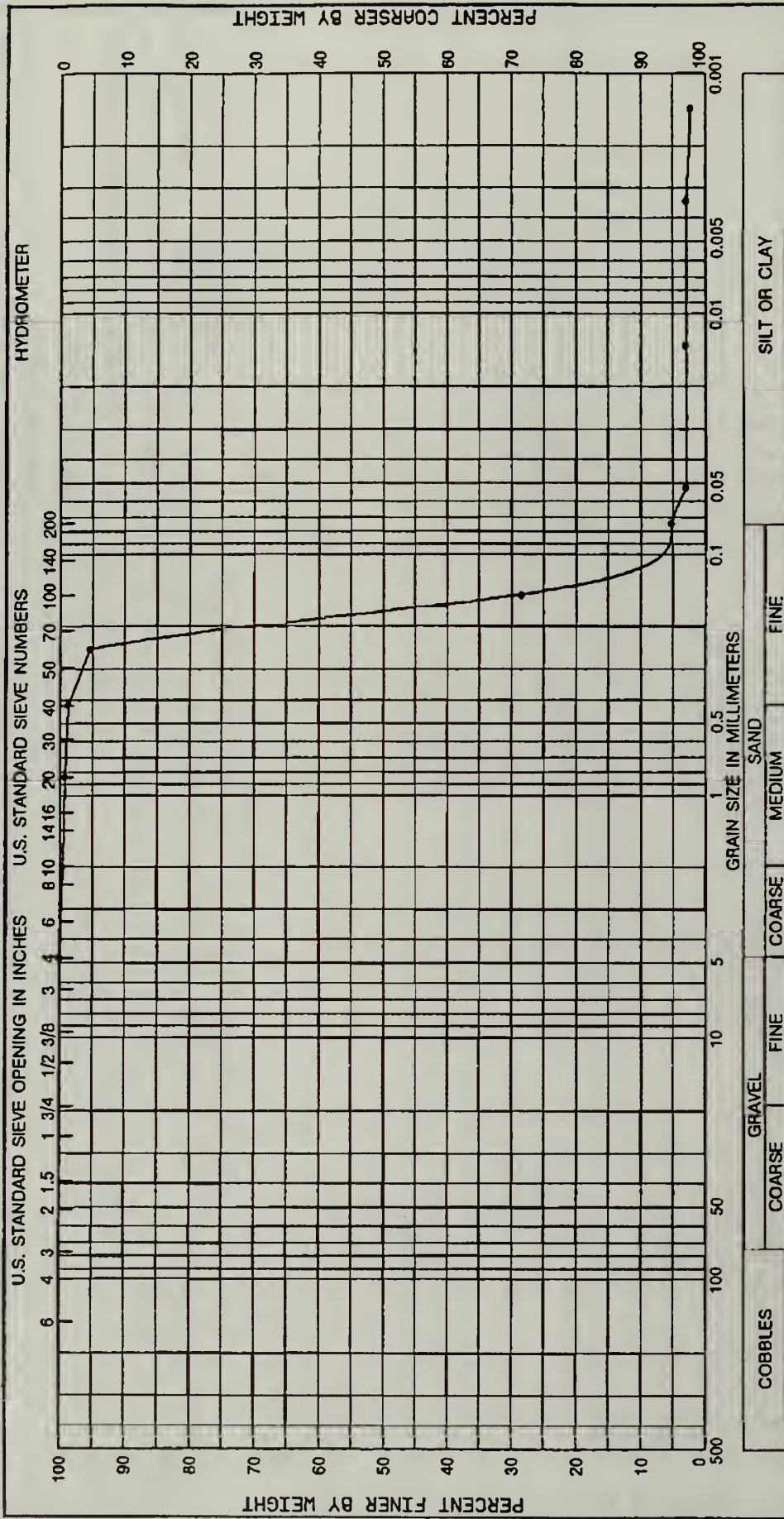


DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

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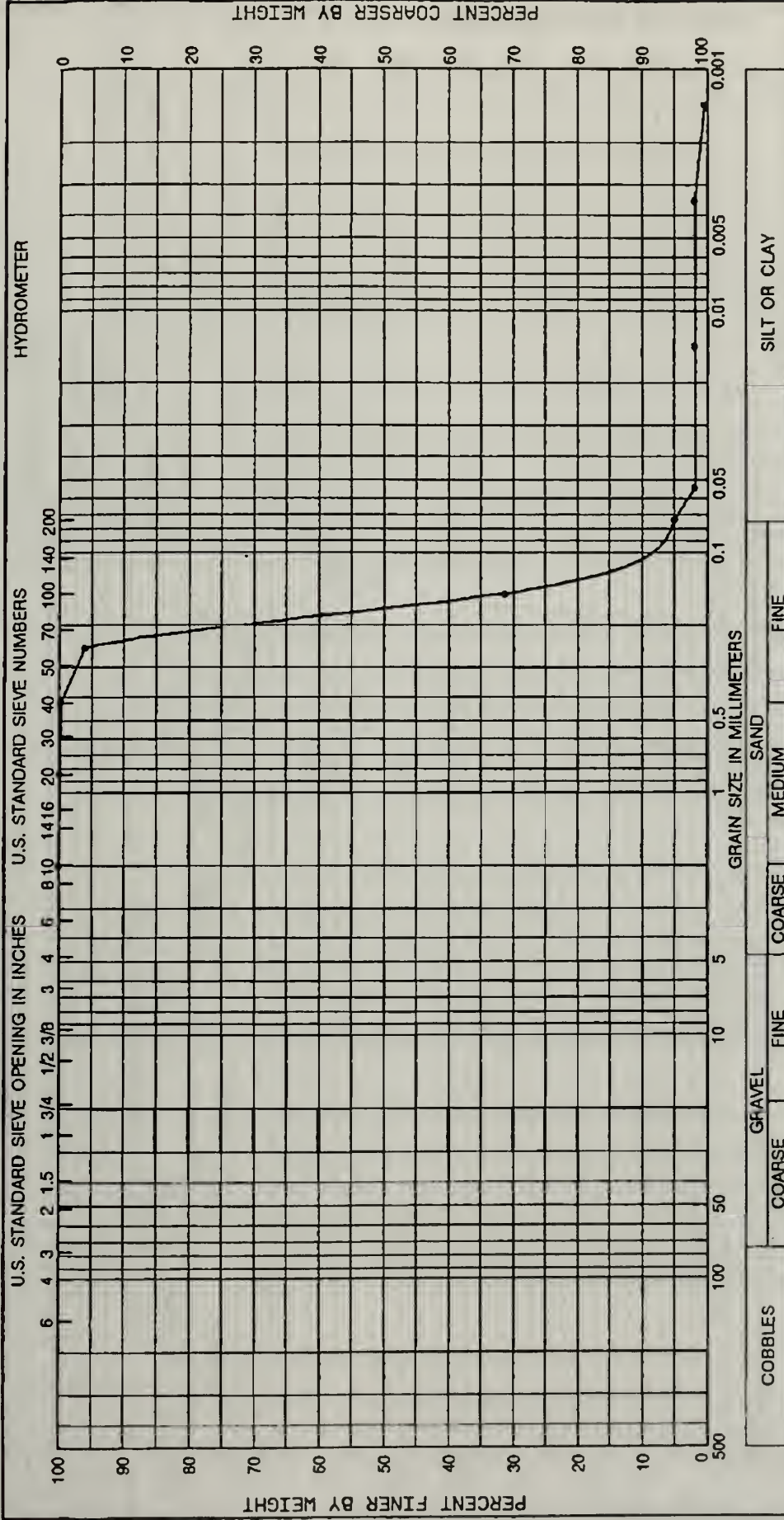


Sample No.	Depth/Elev	Visual	Classification	Nat %K _s	UL	PL	PI	Project	Ft. Sumter	National Monument
1	5.0-6.5'	Tannish gray poorly graded silty sand (SP-SM), with weathered rock fragments.		19.5	--	--	--	Battery Huger Foundation Invest.		
								Lab No. 74/4002		
								Boring No. FS-9-92		
GRADATION CURVES								Date	07/15/92	



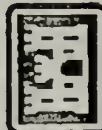
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WORK ORDER: 6636
REQUISITION: SACRM-92-84

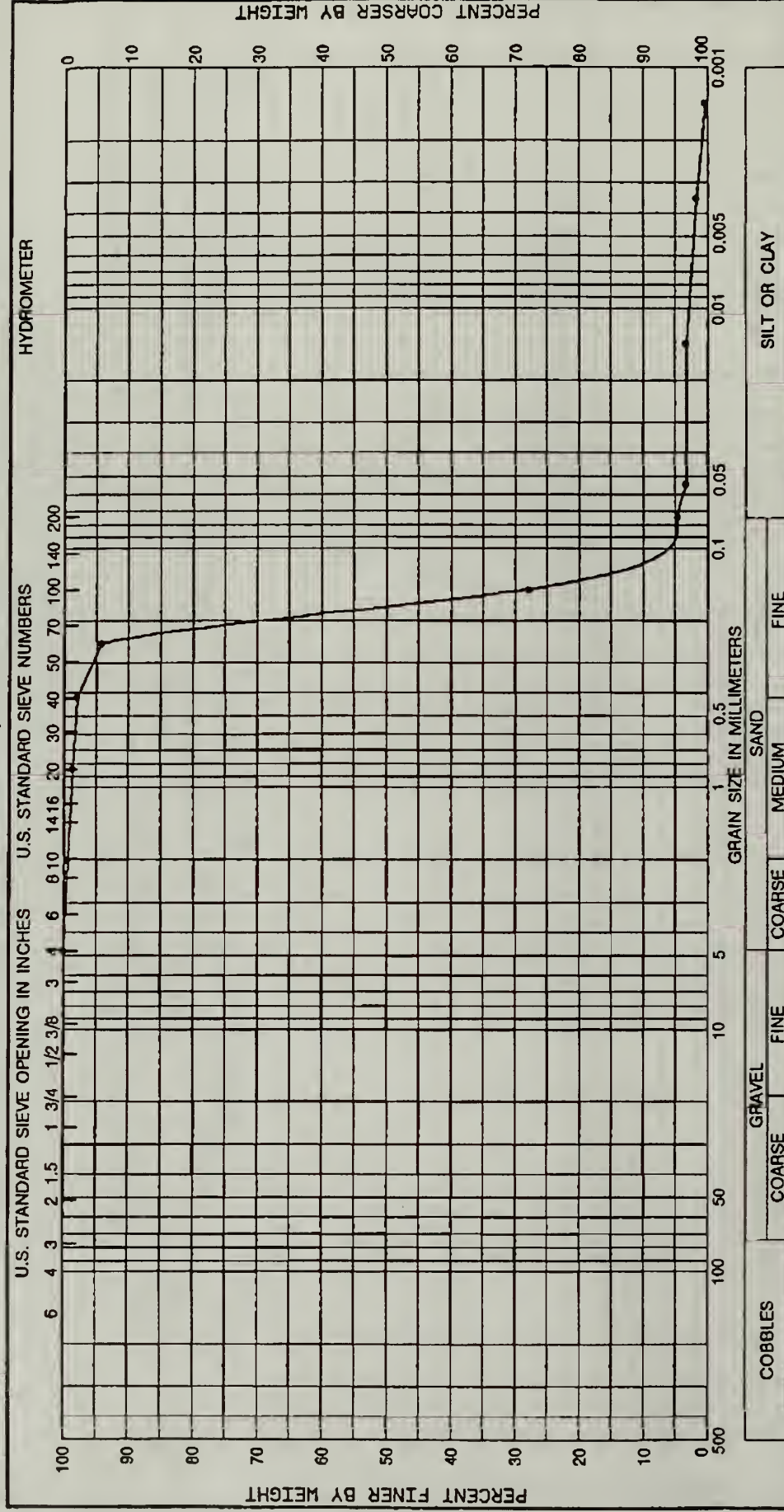


COBBLES		GRAVEL		SAND		FINE		SILT OR CLAY	
Sample No.	Depth/Elev	Classification	Nat w%	LL	PL	PI	Project	Ft. Sumter	National Monument
2	6.5-8.0'	Gray poorly graded silty sand (SP-SM), with a trace of organic matter.	20.9	NP	NP	NP	Battery Huger Foundation Invest.		
							Lab No. 74/4003		
							Boring No. FS-9-92		
							Date 07/15/92		

GRADATION CURVES



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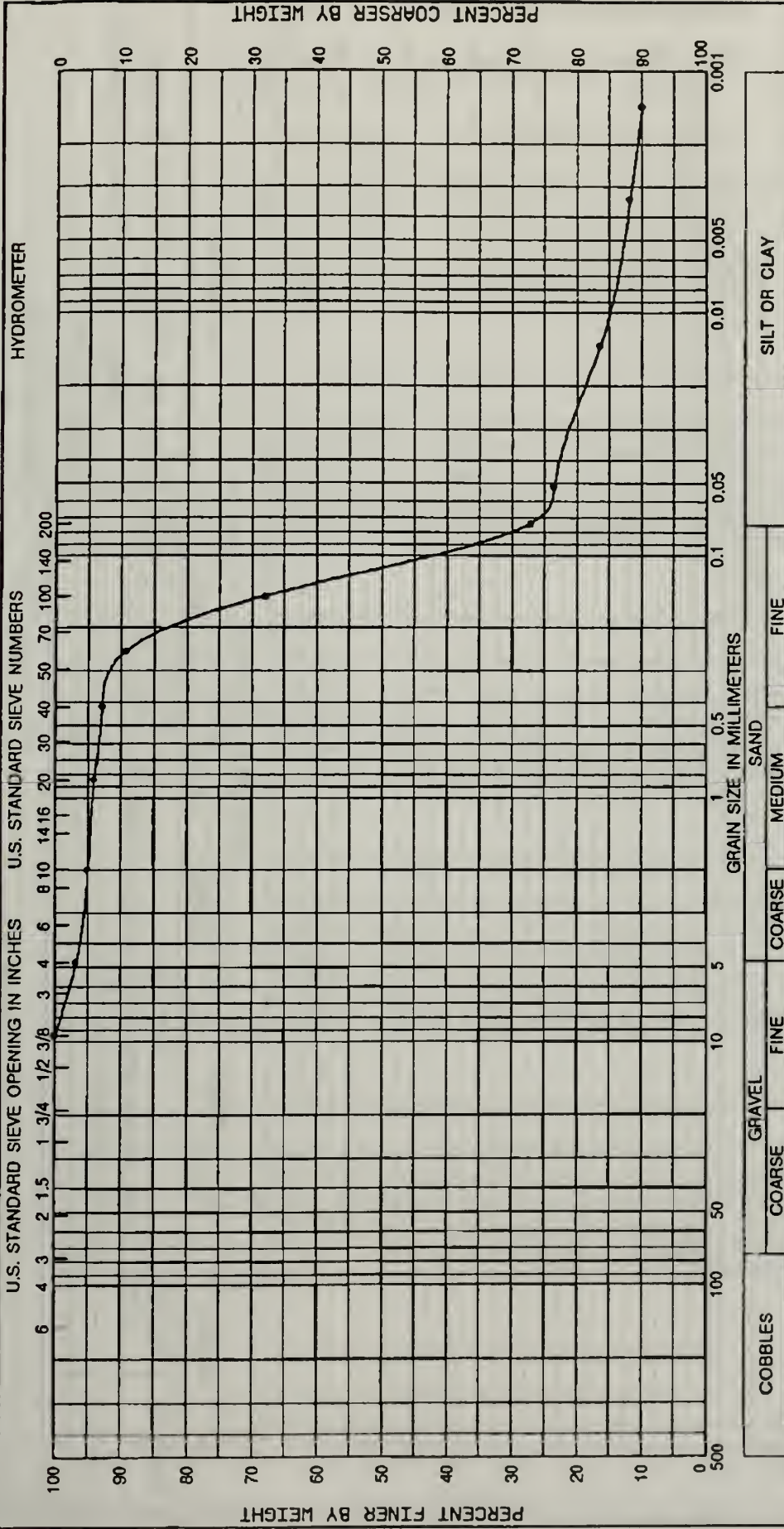


Sample No.	Depth/Elev	Visual	Classification	Nat w%	LL	PL	PI	Project	Ft. Sumter	National Monument
3	8.0-9.3'	Gray poorly	graded sand (SP),	1.3	--	--	--			
										Battery Huger Foundation Invest.
								Lab No.	74/4004	
								Boring No.	FS-9-92	
GRADATION CURVES								Date	07/15/92	



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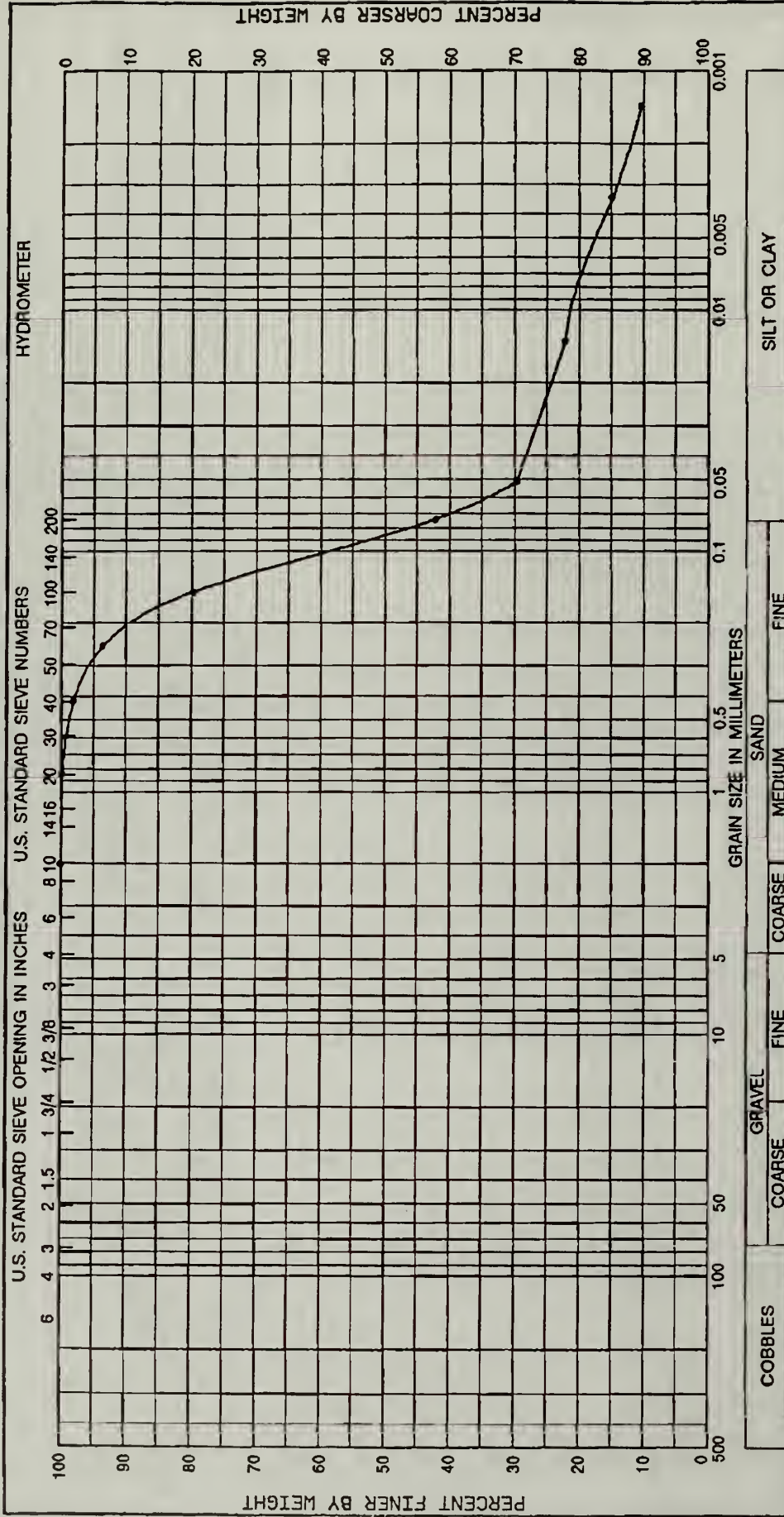
WORK ORDER: 6636
REQUISITION: SACRM-92-84



Sample No.	Depth/Elev	Visual	Classification	Net w%	LL	PL	PI
4	13.0-14.5'	Gray clayey sand (SC), with a trace of gravel size weathered rock fragments (calcareous sizes), and with a trace of mica.		42.3	--	--	--
GRADATION CURVES							
Project				Ft. Sumter National Monument			
				Battery Huger Foundation Invest.			
				Lab No. 74/4005			
				Boring No. FS-9-92			
				Date 07/15/92			

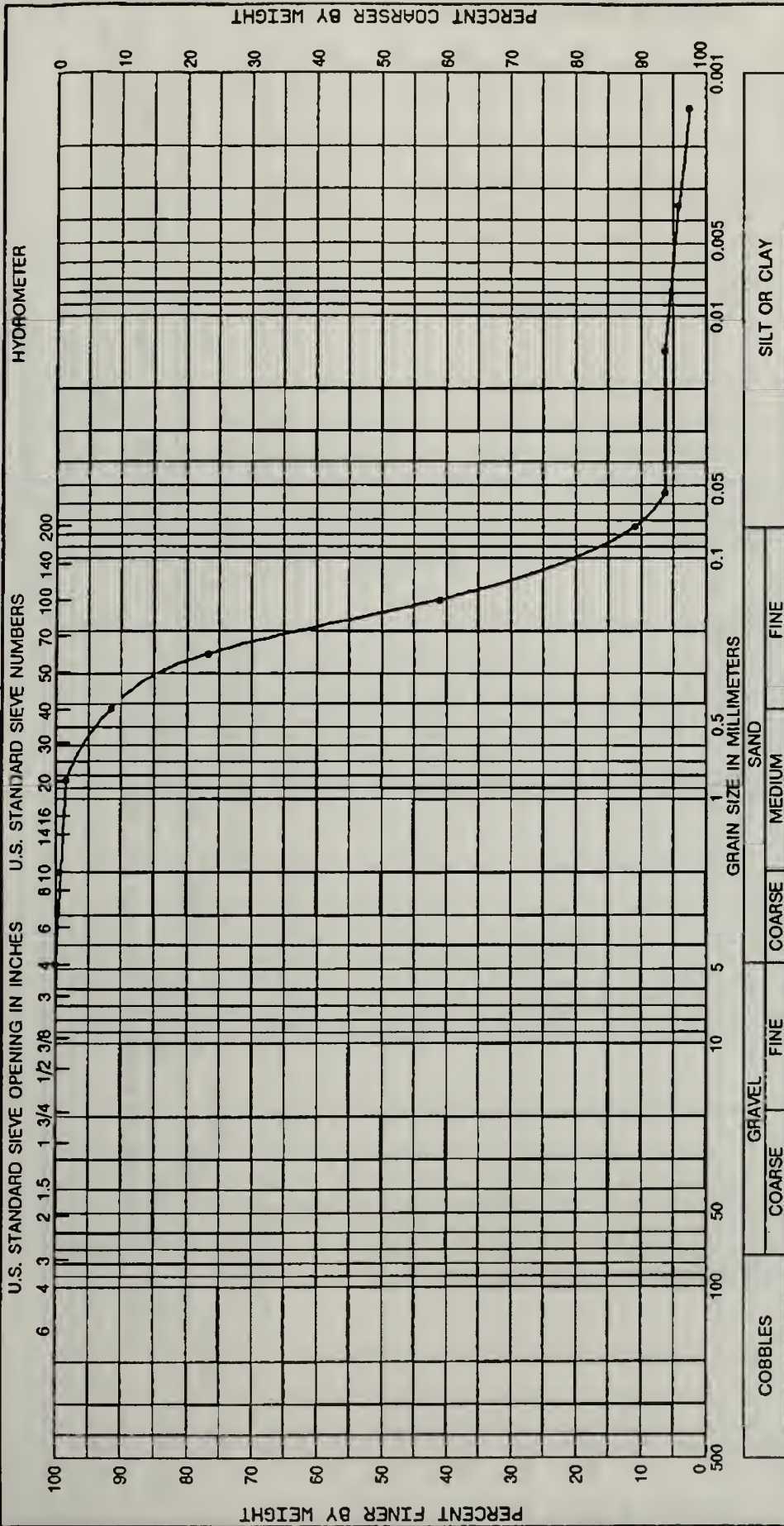


WORK ORDER: 6636
REQUISITION: SACRM-92-84

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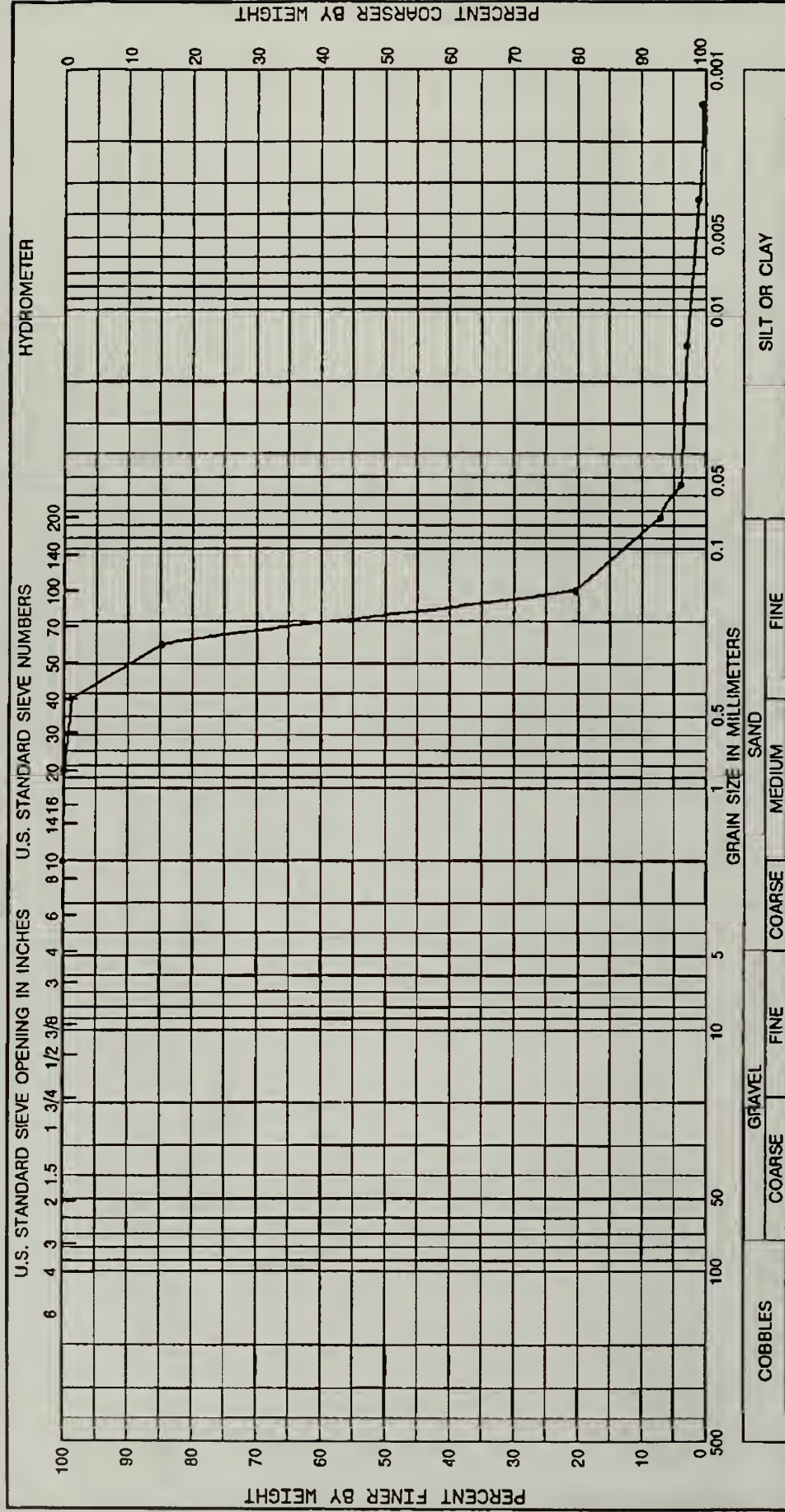
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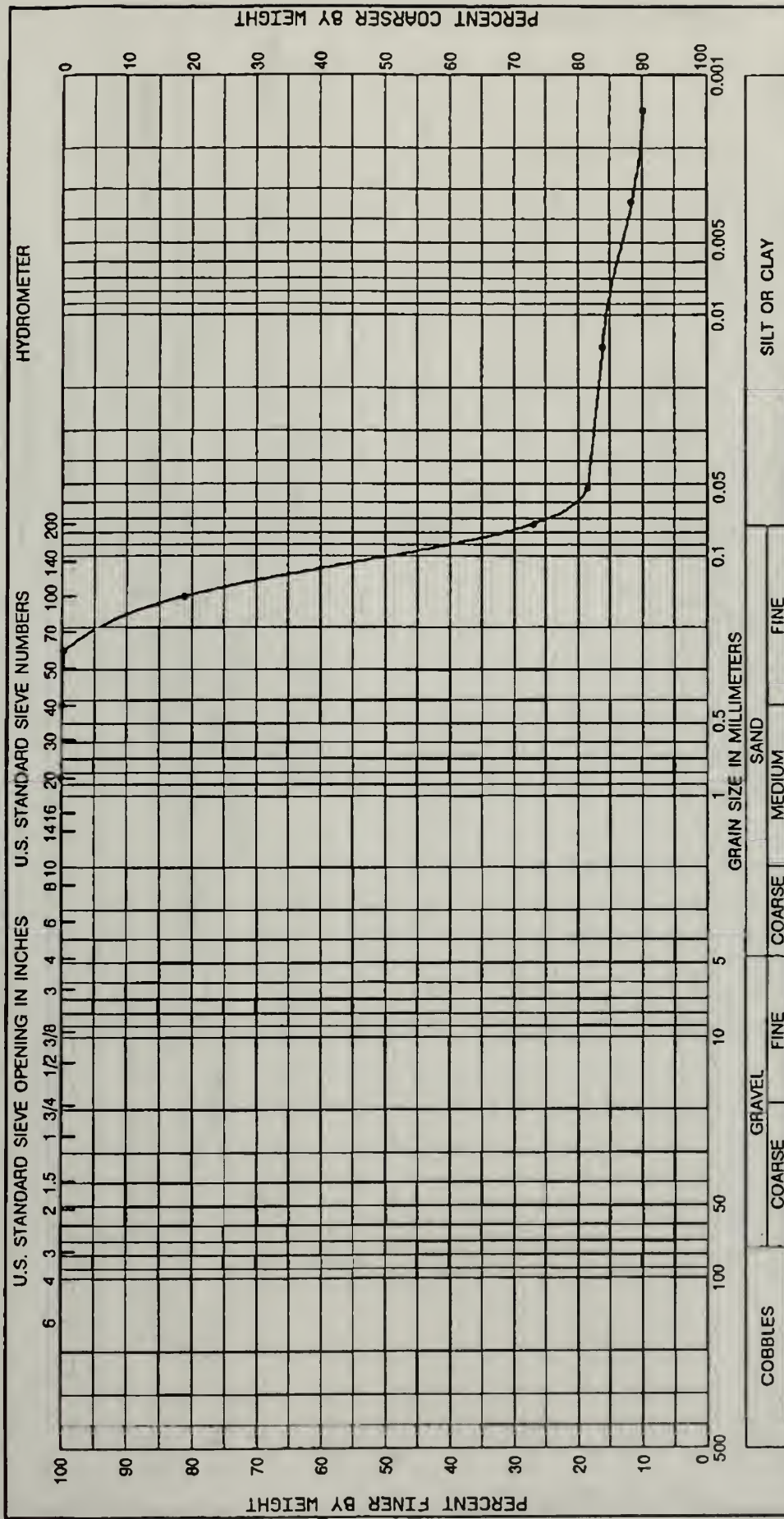
Sample No.	Depth/Elev	Classification	Nat w%	LL	PL	PI
7	17.5-19.0'	Gray poorly graded silty sand (SP-SM), with a trace of mica.	25.8	NP	NP	NP
GRADATION CURVES						
Project Ft. Sumter National Monument			Battery Huger Foundation Invest.			
			Lab No. 74/4007			
			Boring No. FS-9-92			
			Date 07/15/92			



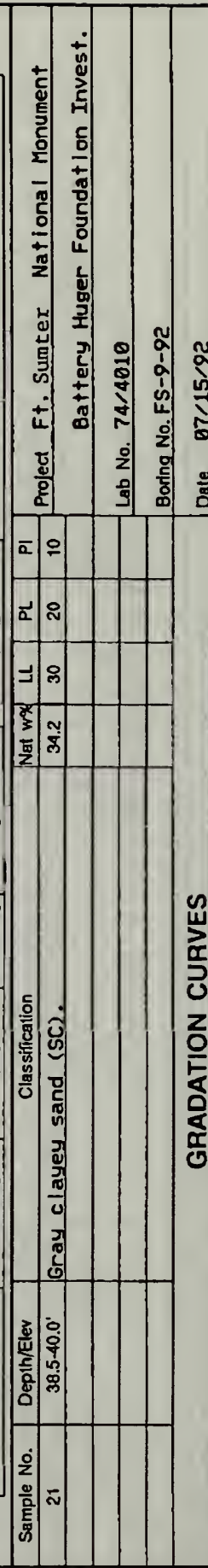
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WORK ORDER: 6636
REQUISITION: SACRM-92-84

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WORK ORDER: 6636
REQUISITION: SACRM-92-84

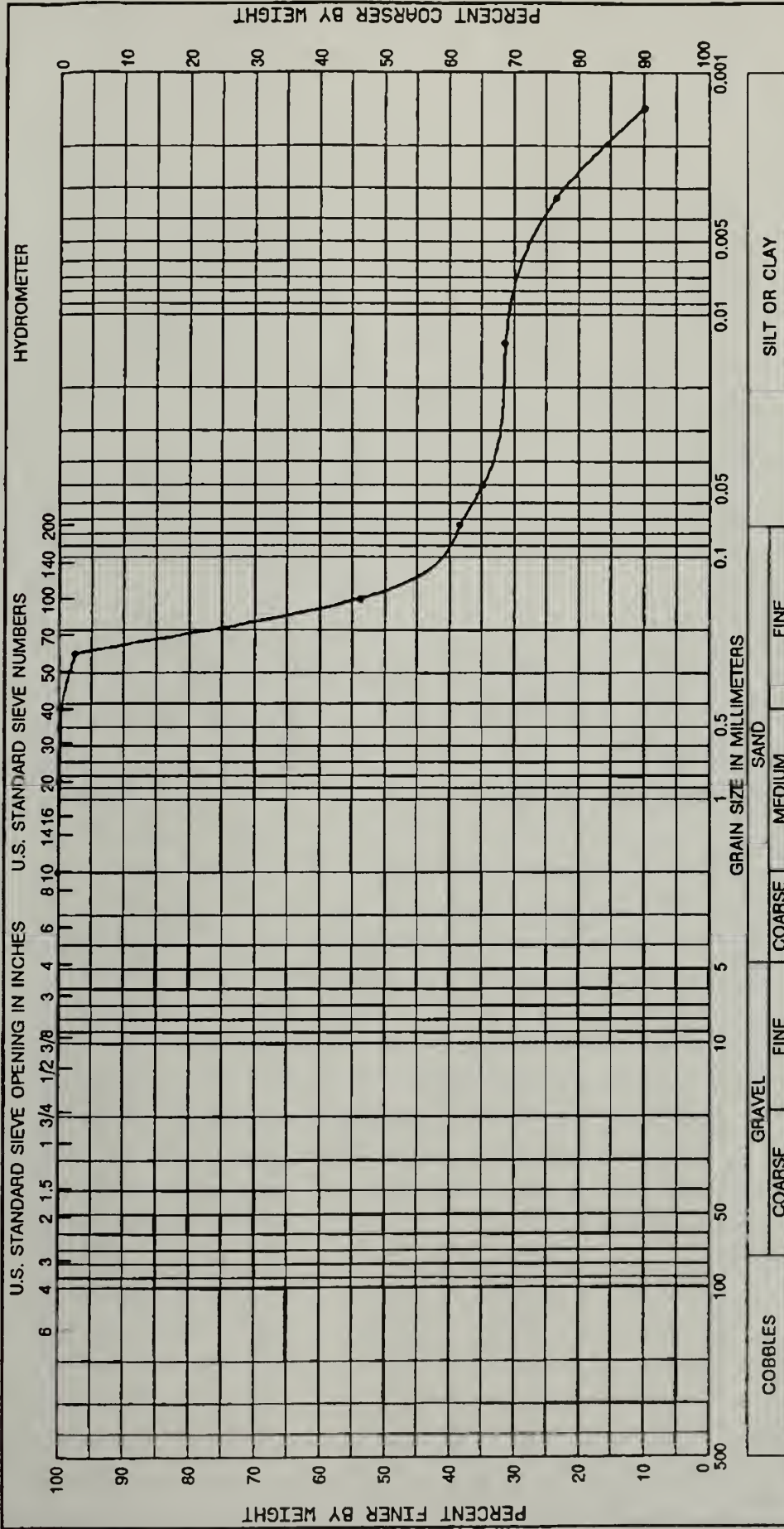


GRADATION CURVES



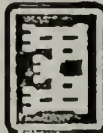
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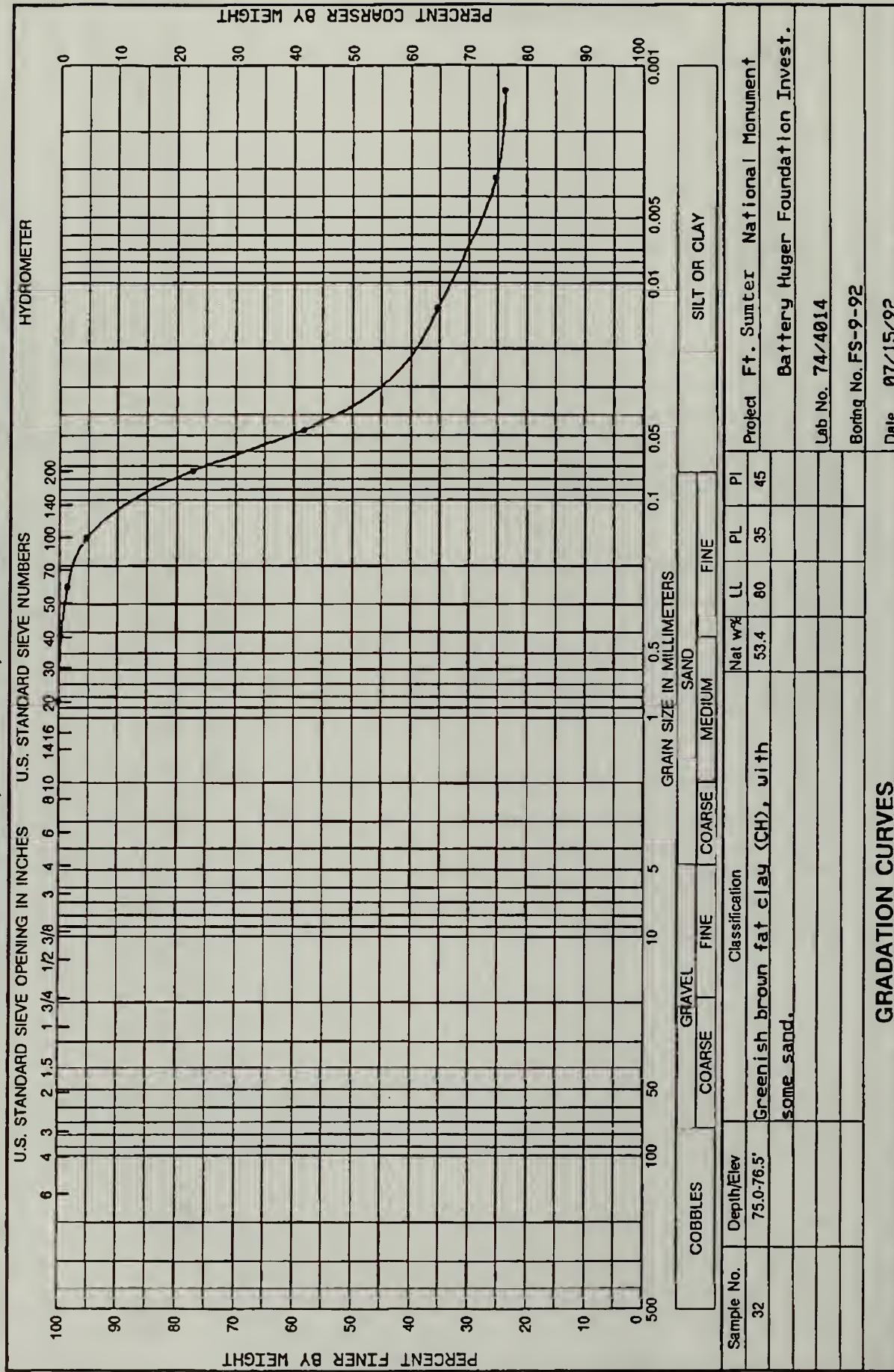
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Sample No.	Depth/Elev	GRAVEL				SAND			SILT OR CLAY		
		COARSE	FINE	COARSE	MEDIUM	FINE	PI	PL	PI		
26	55.0-56.5'	Gray clayey sand high LL (SC-H).				Nat w%	40.3	51	21	30	Project Ft. Sumter National Monument
											Battery Huger Foundation Invest.
											Lab No. 74/4012
											Boring No. FS-9-92
											Date 07/16/92

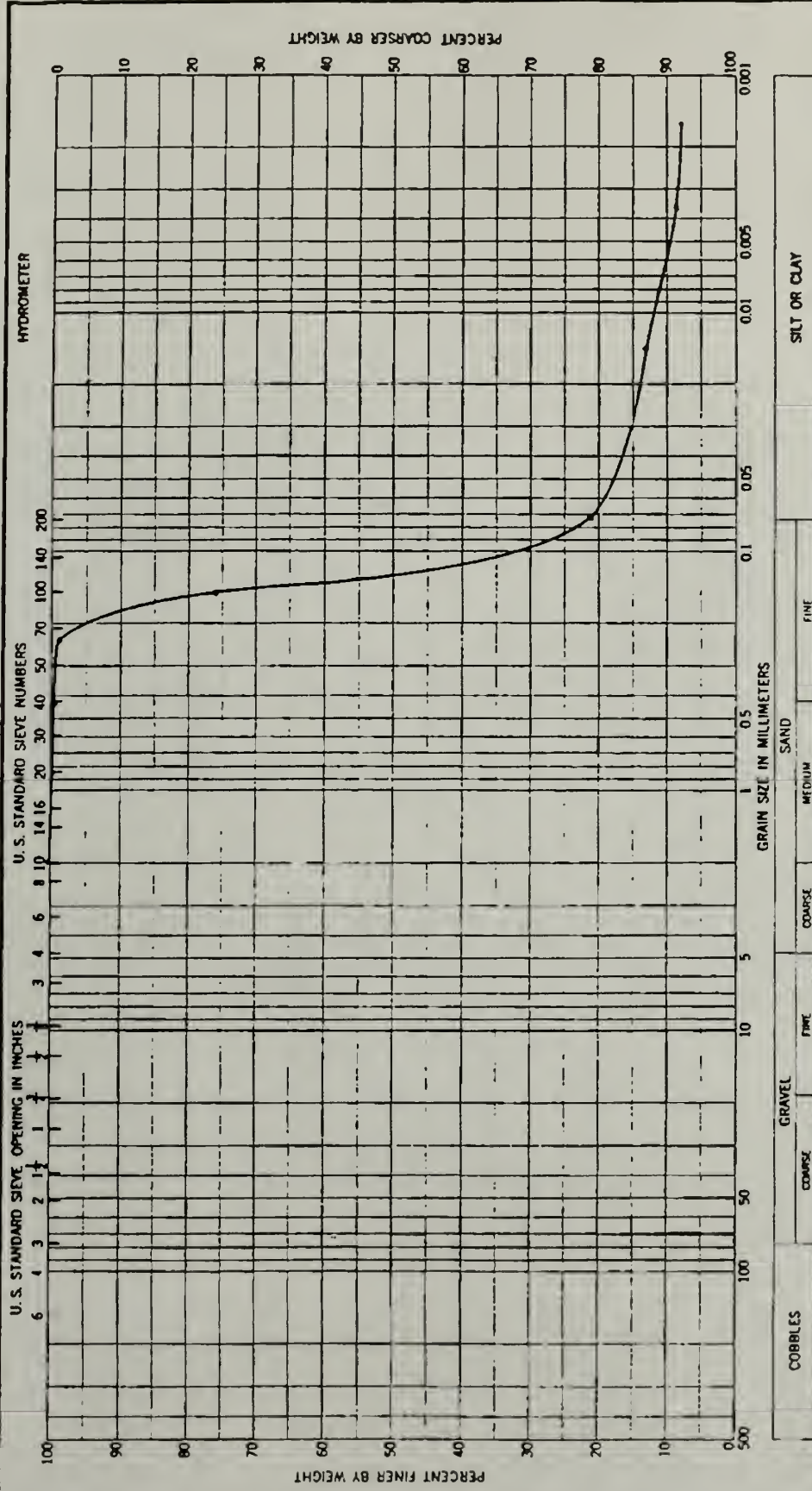
GRADATION CURVES





SOUTH ATLANTIC DIVISION LABORATORY
US ARMY CORPS OF ENGINEERS
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Sample No	6A	Elev or Depth	36.5-38.5'	Classification	Gray, clayey sand (SC), w/ a trace of mica	Net w %	38.3	LL	29	PL	22	PI	7
GRADATION CURVES													
Project Ft. Sumter National Monument													
Lab. No. 96/635*													
Area Battery Huger Investigation													
Boring No. FS-10-92, sample no. 6A													
Date 14 May 92													

South Atlantic Division Laboratory
US Army Corps of Engineers
611 South Cobb Dr.
Marietta, GA 30060-3112

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REQ. NO. SACRM-92-84

